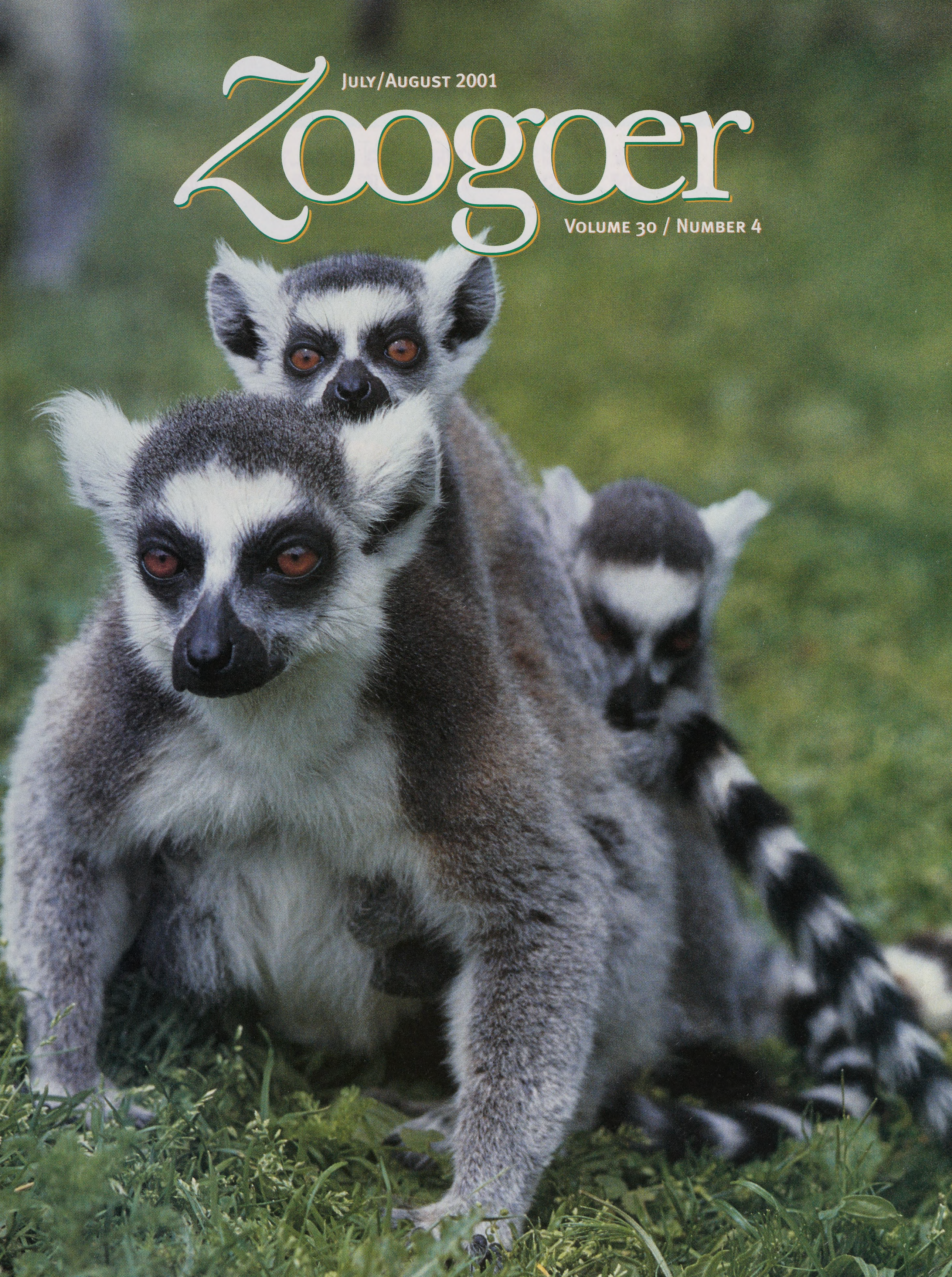
July/August 2001

Zoogoer

Volume 30 / Number 4



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Get the latest on condors in the Grand Canyon, elephant seals off Australia, phantoms in Rome—and projects right in your own backyard.

THE FUTURE OF CRC

As many of you know by now, Smithsonian Secretary Lawrence M. Small has withdrawn his proposal to close the Smithsonian National Zoo's Conservation and Research Center (CRC) by the end of the year. He has also announced that he is forming a blue-ribbon commission to study the Smithsonian Institution's science programs and advise him on the best direction for their future. The FONZ Board of Directors is grateful for both decisions and anticipates that CRC will continue to play an important role in fulfilling the Zoo's mission.

While the FONZ Board opposed closing CRC, we understand the financial constraints faced by the Smithsonian. The National Zoo is simply under-funded. The Zoo has long been struggling to maintain the high quality of its programs and facilities in Washington, D.C., and Front Royal, Virginia. While one way out of this funding dilemma was to shut down the CRC facility and move many of the programs based there to Washington, the FONZ Board urged that other courses of action be fully explored. In a letter to Senator Conrad Burns, Chairman of the Appropriations Subcommittee on Interior and Related Agencies, we asked that the Zoo be given additional funding to support both a great Zoo and a great Conservation and Research Center. [For the full text of the letter, go to: www.fonz.org/faq/crcletter.htm.]

As I write, the amount of the Zoo's future federal appropriations remains unknown. But the future direction of the Zoo is clear from the vision outlined by Zoo Director Lucy Spelman. Zoo staff will be working over the next ten years to develop new facilities and programs for Asian elephants, sloth bears, and other charismatic Zoo species. These programs, which will be as comprehensive as the program for giant pandas, will include building a world-class exhibit and Zoo habitat (partially funded with federal appropriations), providing education about the species, and conducting conservation efforts in the wild as well as at zoos (funded with private and corporate donations). Each of these components will be enhanced by the depth and breadth of the Zoo's scientific research.

We at FONZ support this vision wholeheartedly and believe that these programs will greatly benefit our members and the visiting public, as well as the animals whom we seek to save for future generations. As we await actions by Congress and guidance from the blue-ribbon commission that is being set up to advise the Smithsonian's science programs, FONZ's goal remains clear: In order to help accomplish the Zoo Director's vision, we will have to redouble our efforts to raise private donations and corporate contributions. FONZ is proud of the success of its Capital Campaign, which has raised almost $22 million to support the Giant Panda Conservation Program. Now our challenge is to help build support for other equally threatened and endangered species.

Our task is large, but with the continued support of our members and the community, I believe we are up to it.

David Perry

David Perry
President
Friends of the National Zoo

Friends of the National Zoo is a nonprofit organization of individuals, families, and organizations who are interested in helping to maintain the status of the Smithsonian's National Zoological Park as one of the world's great zoos, to foster its use for education, research, and recreation, to increase and improve its facilities and collections, and to advance the welfare of its animals.

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Membership in FONZ offers many benefits: publications, discounts on shopping, programs, and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, National Zoological Park, Washington, DC 20008, call 202.673.4961 or go to www.fonz.org.

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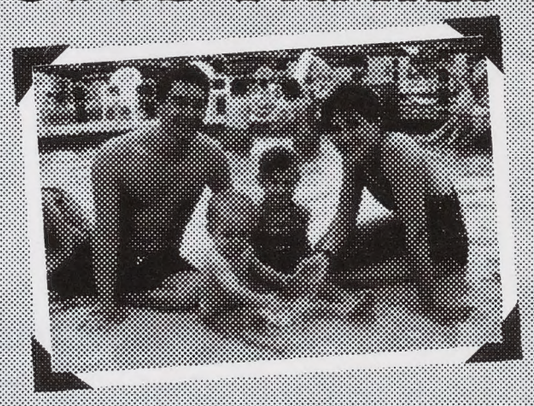

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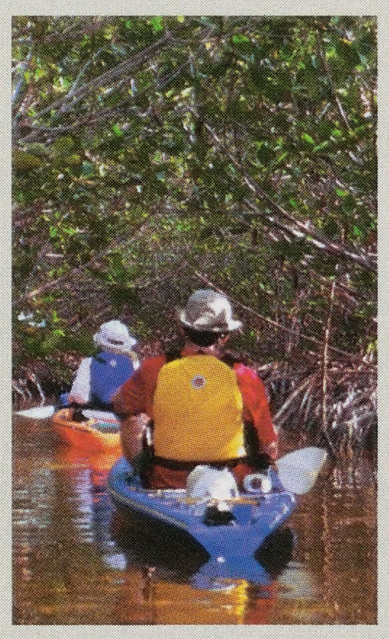

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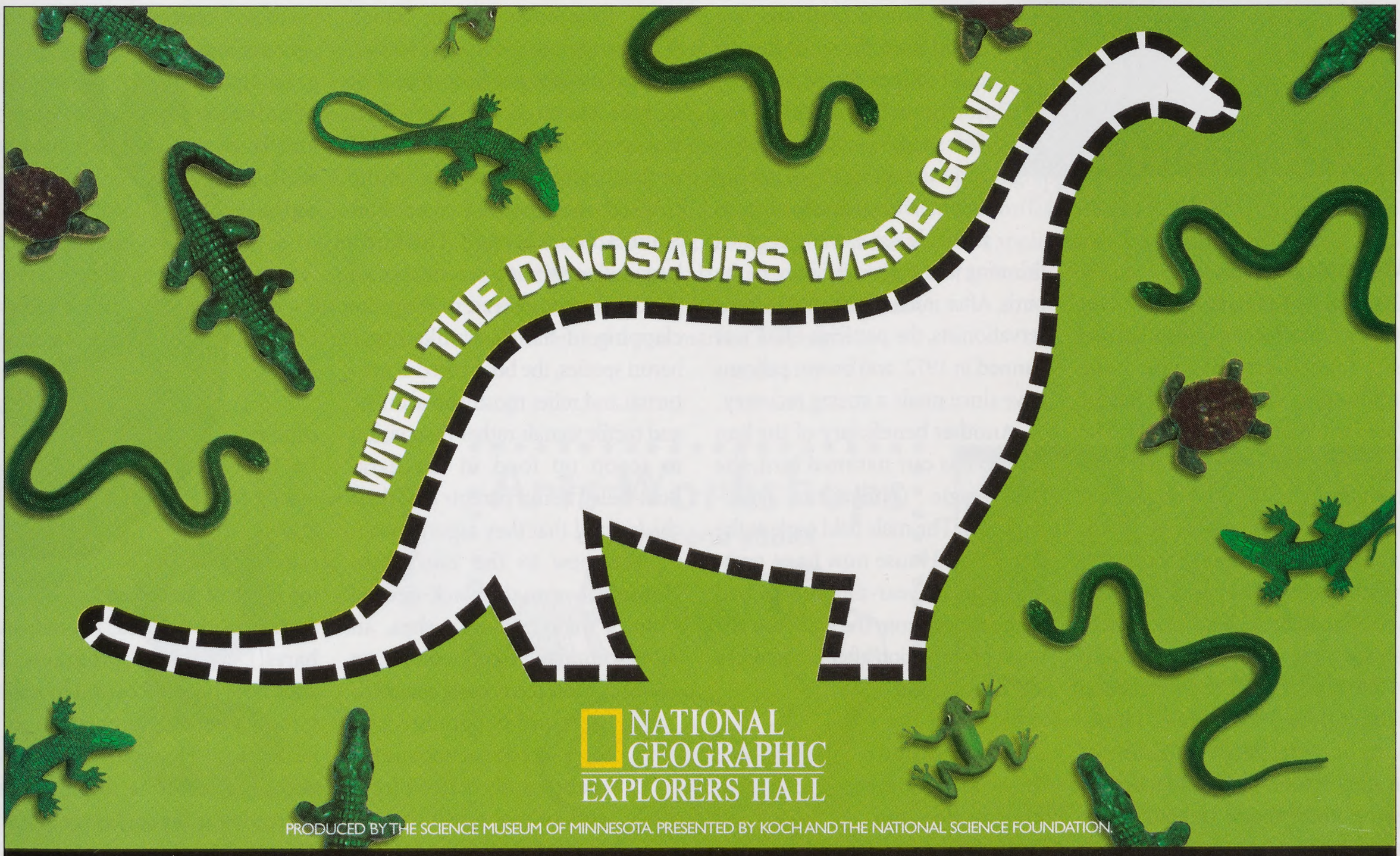

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NOTES & NEWS

JESSIE COHEN/NZP (AND BELOW)

ONE OF THREE NEW MEXICAN WOLVES AT THE ZOO.

ANIMAL NEWS

Three male Mexican gray wolves (*Canis lupus baleyi*)—also known as lobos—arrived in the Smithsonian National Zoo's Beaver Valley on Wednesday, May 30. The three-year-old brothers come to us from the Wild Canid Survival and Research Center outside St. Louis, Missouri. The National Zoo may eventually receive a female to breed with one of the males, and hopes to release some of them into the wild in the coming years. In their natural habitat, lobos form small family units or social packs consisting of an adult breeding pair and their offspring. Both parents and other pack members bring food to the young. You can read about the conservation status of Mexican wolves, and the reintroduction effort now underway, in the May/June 2001 *ZooGoer* (see www.fonz.org/zgintro.htm).

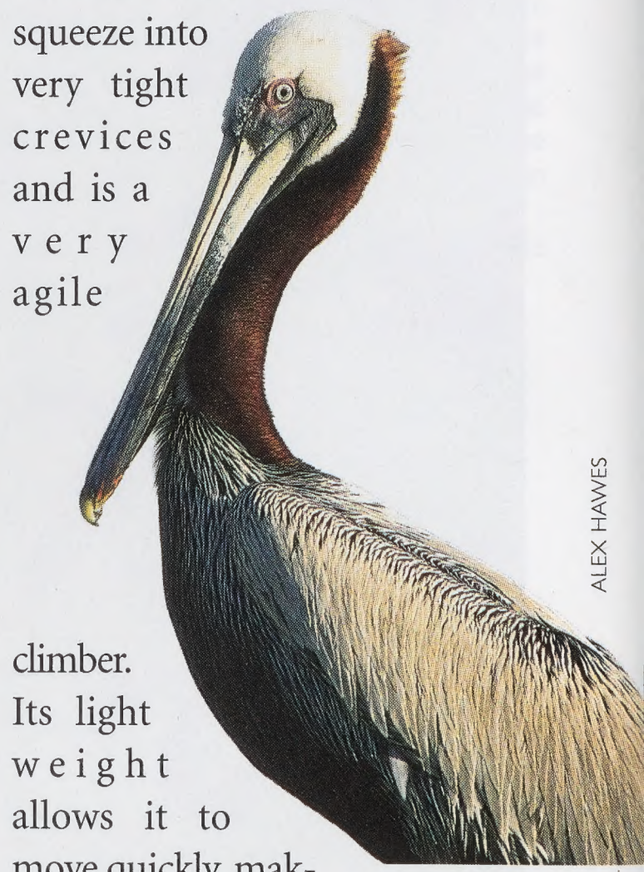
Bird is the word at the National Zoo this spring. Three brown pelicans (*Pelecanus occidentalis*)—one female and two males—have arrived at the Zoo's sea lion pool, just across the Valley Trail from the new wolves. Wild brown pelicans are found from the southeastern coast of the United States to northern Brazil and Chile. This species had been listed as endangered in 1970, having declined drastically due to pesticide use causing eggshell thinning and breeding failure in the birds. After intense lobbying by conservationists, the pesticide DDT was banned in 1972, and brown pelicans have since made a strong recovery.

Another beneficiary of the ban on DDT is our national bird, the bald eagle (*Haliaeetus leucocephalus*). The male bald eagle at the Zoo's Bird House now has a partner! The 15-year-old female had been rescued from the wild near the point of starvation after sustaining a leg injury, and could not be released back into the wild because she could not hunt. After several months of recuperating at the Zoo, she was introduced to our resident male in the outdoor bald eagle flight exhibit. So far, the introduction seems to be going very smoothly; Zoo staff are hoping to greet bald eagle hatchlings someday soon. In the wild, these birds live in monogamous pairs, but after one dies the survivor will not hesitate to accept a new mate. Wild bald eagles are now present in every state, except Hawaii, as well as in the District of Columbia.

A boat-billed heron chick (*Cochlearius cochlearius ridgwayi*) cracked its pale, greenish-blue shell in mid-March at the Zoo's Bird House. *Kwahh-kwa-kwo-ko*, the call of this heron, carries through the tropical swamps of Central and South America at night. This bird's large bill serves as a resonator and produces sounds resembling the clapping of hands. Unlike other heron species, the boat-billed is nocturnal and relies mostly on acoustic and tactile signals rather than vision to scoop up food in the dark. Boat-billed heron parents feed their chicks food that they regurgitate.

Also new to the Zoo's Bird House are a male black-necked swan, a male common rhea, an adolescent female king vulture, an adolescent male magnificent bird of paradise, and three crested cormorants that recently arrived from an animal rehabilitation center in Florida. Ten flamingo chicks are now being reared by their parents, too.

The Reptile House was also visited by the stork, metaphorically speaking, when a new pancake tortoise (*Malacochersus tornieri*) hatched on May 13. The baby is on exhibit by itself, surrounded by exhibits featuring other baby reptiles. It has a dark, rounded shell with yellow blotches. As the baby grows older, its shell will flatten out. Its pancake-like profile offers unique physical capabilities. The pancake tortoise can squeeze into very tight crevices and is a very agile climber. Its light weight allows it to move quickly, making it one of the fastest turtles in the world. (Watch out hares!) Breeding programs in zoos have been successful in maintaining the zoo population at a healthy level. However, wild pancake turtle populations in Africa are decreasing as the turtles are becoming popular pets.



ALEX HAWES

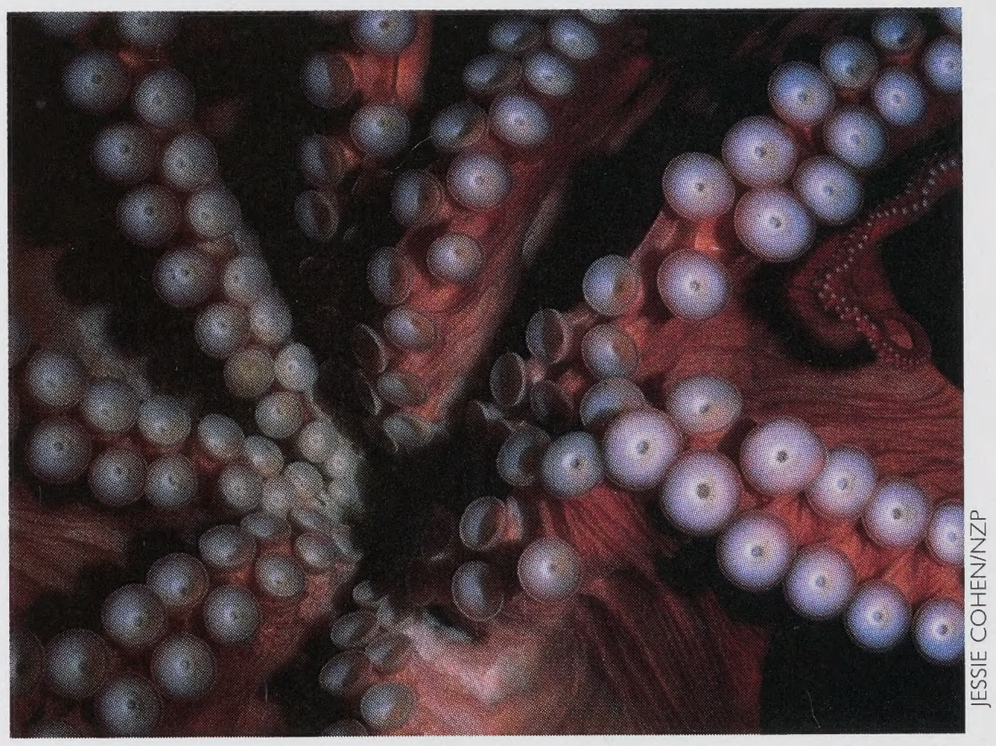
BROWN PELICAN.

WORD FROM UNDERWATER

What are those new, bizarre-looking snakes at the Reptile Discovery Center? They are tentacled snakes (*Erpetum tentaculum*), natives of Southeast Asia. These snakes live in stagnant or slow-moving bodies of water. They get their name from the two unusual tentacles they bear on their snout, the purpose of which is unknown. Tentacled snakes are totally aquatic and grow to nearly three feet long. Ten were introduced to their aquatic exhibit at the Zoo on May 18. Since then, they have been so well camouflaged among the floating branches that they are hard to discern.

Four freshwater stingrays (*Potamotrygon* spp.) have arrived in Amazonia. Freshwater stingrays are widely distributed, occurring in tropical lakes and rivers of South America and West Africa. They are bottom-feeding omnivores. Their sting is extremely painful to people, and a victim's wound often becomes infected.

On May 24, the Invertebrate Exhibit also welcomed a 12-pound female giant Pacific octopus (*Octopus dofleini*)—the largest octopus species in the world. She was taken off the coastal waters of Vancouver in British Columbia. Octopuses live only in oceans, never in freshwater. They are rather small in warm tropical waters, and large in colder waters such as the North Pacific. Octopuses have well-developed brains and excellent eyesight; their intelligence is sometimes compared to that of a house cat. The body of the octopus, called the mantle, looks like a bag that can shrivel to fit in tight crevices. Inside the mantle sit the stomach and all the other organs, including three hearts pumping a pale blue blood through the animal's body.



JESSIE COHEN/NZP

GIANT PACIFIC OCTOPUS (*OCTOPUS DOFLEINI*).

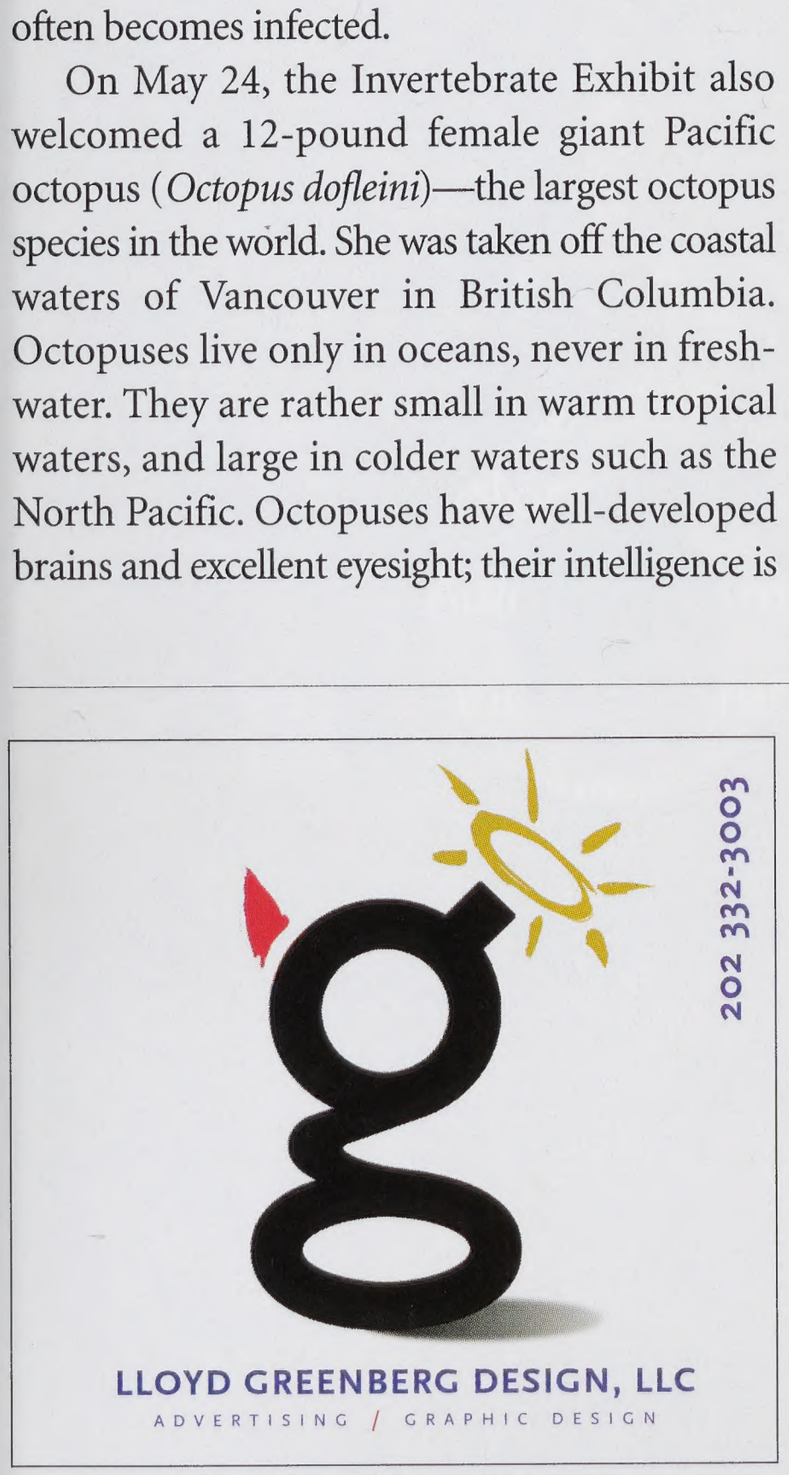
At the Zoo, our female will be part of an enrichment research program. Zoo staff will put baskets and floating colored balls in her aquarium to encourage her to explore the surroundings. They will then monitor her reactions in order to find the best ways to improve her welfare. Some octopuses in zoos have learned to identify patterns and run mazes, while others have been trained to find crabs in hidden places, such as behind doors marked with signs.

If you visit the Invertebrate Exhibit in the morning or late afternoon, you may catch her feeding. After she unfolds her long tentacles to taste her food with her suckers, she grabs it firmly and engulfs it in her mouth. Meanwhile, the texture and color of her skin undergo dramatic changes, turning from a bumpy dark purple to a smooth bright red.

SHOW US YOUR WILD SIDE!

Enter the first-ever Giant Panda Photo Contest and become a producer for a day for Discovery Communication's Animal Planet. Send in up to three black-and-white or color photos (5" x 7" or larger) of the Zoo's giant pandas, Mei Xiang and Tian Tian, and you may win a private screening of an Animal Planet program not yet shown to the public, as well as lunch with a top-notch program producer, and a high-tech editing session. Prizes for winners and runners-up in the Adult and Junior (12 & under) categories also include Fuji digital cameras, Ritz Camera Center gift certificates, and an engraved panda paver at the National Zoo. The contest is open to amateur photographers; there is no fee to enter. Deadline for entries is August 31, 2001. For rules and contest applications, log onto www.fonz.org, email photocontest@fonz.org, or call 202.673.4613.

—*Annie Saint-Amand*



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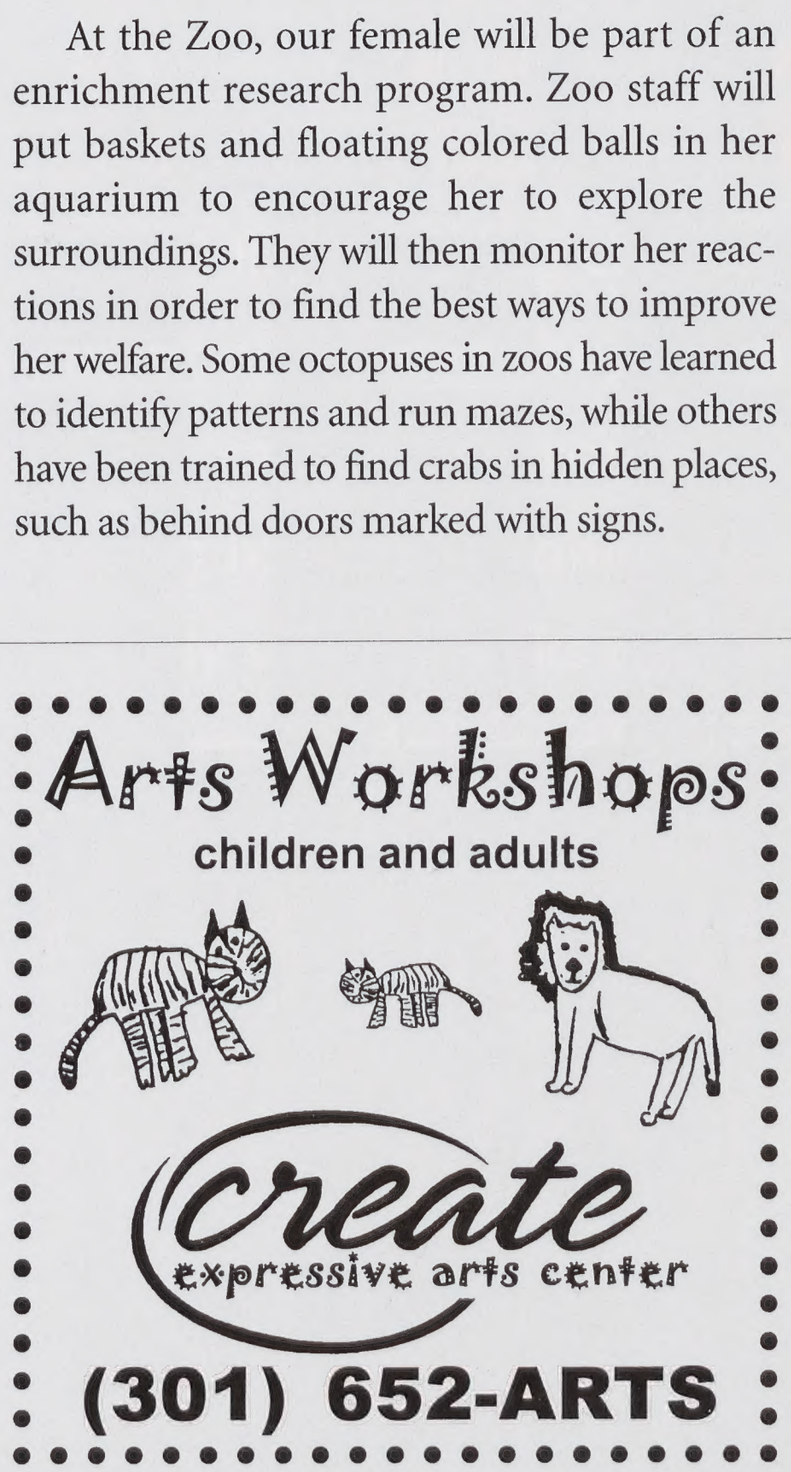
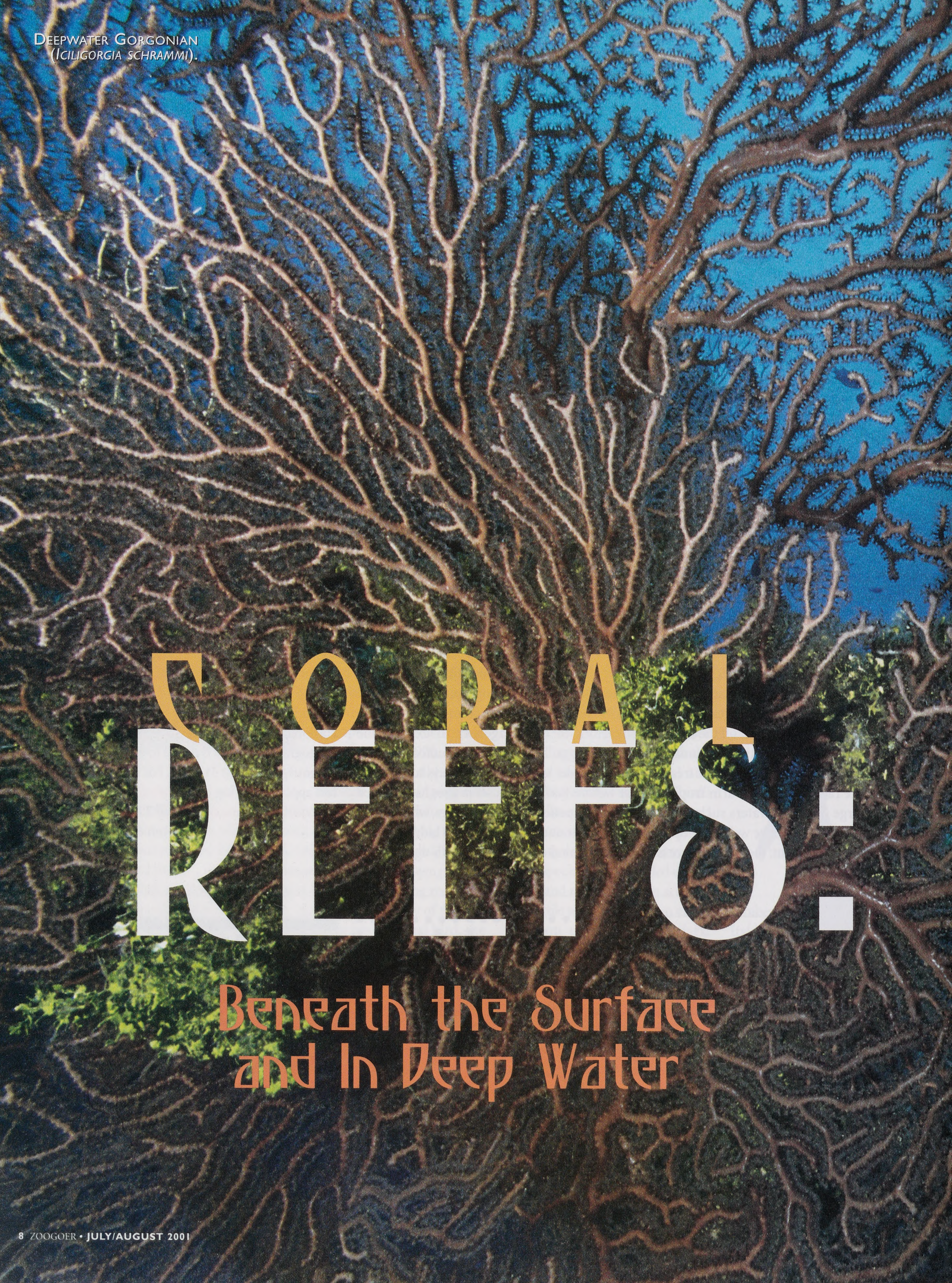
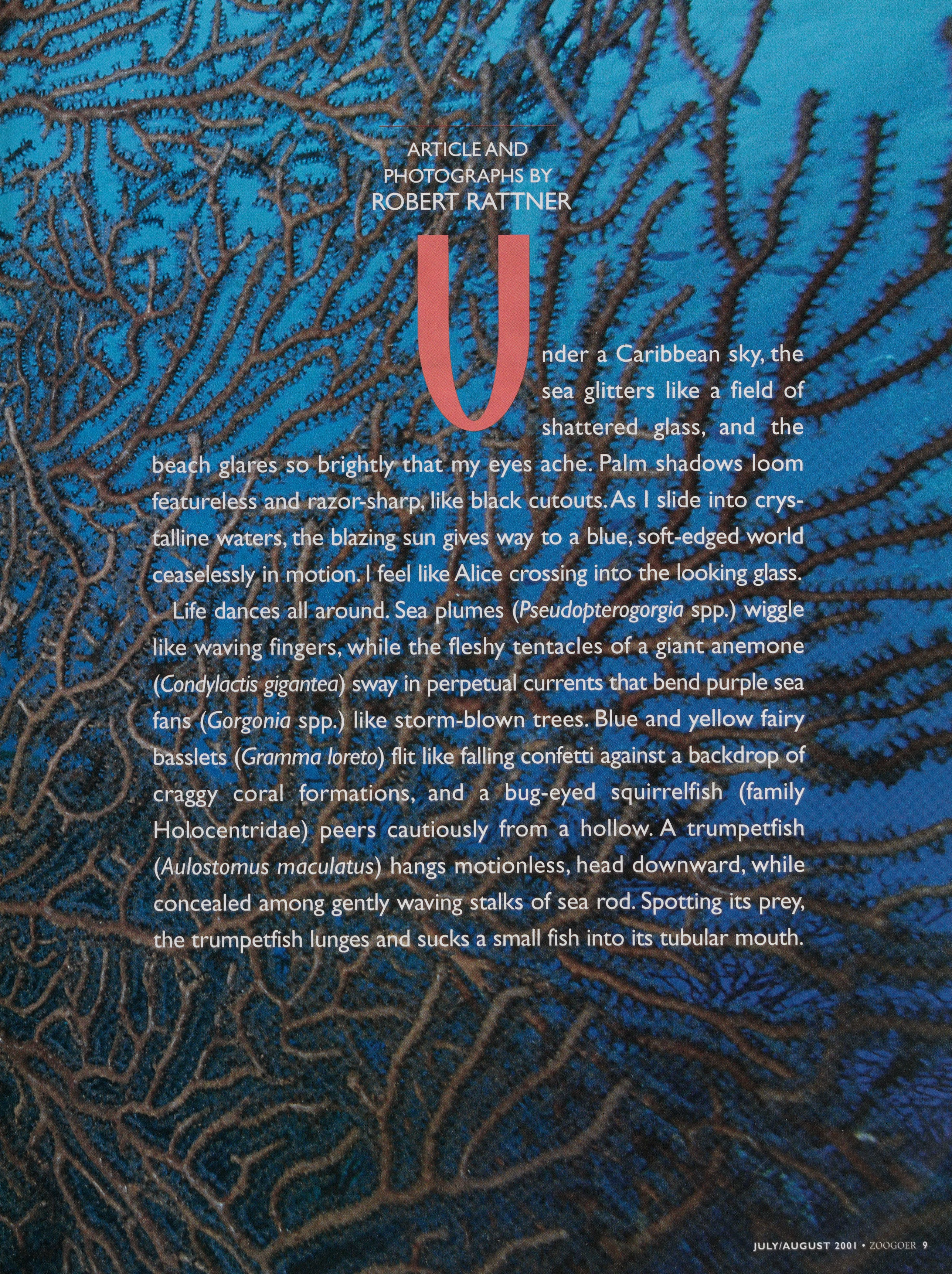




DEEPWATER GORGONIAN (*ICILIGORGIA SCHRAMMI*).

CORAL REEFS:

Beneath the Surface and In Deep Water



ARTICLE AND PHOTOGRAPHS BY
ROBERT RATTNER

Under a Caribbean sky, the sea glitters like a field of shattered glass, and the beach glares so brightly that my eyes ache. Palm shadows loom featureless and razor-sharp, like black cutouts. As I slide into crystalline waters, the blazing sun gives way to a blue, soft-edged world ceaselessly in motion. I feel like Alice crossing into the looking glass.

Life dances all around. Sea plumes (*Pseudopterogorgia* spp.) wiggle like waving fingers, while the fleshy tentacles of a giant anemone (*Condylactis gigantea*) sway in perpetual currents that bend purple sea fans (*Gorgonia* spp.) like storm-blown trees. Blue and yellow fairy basslets (*Gramma loreto*) flit like falling confetti against a backdrop of craggy coral formations, and a bug-eyed squirrelfish (family Holocentridae) peers cautiously from a hollow. A trumpetfish (*Aulostomus maculatus*) hangs motionless, head downward, while concealed among gently waving stalks of sea rod. Spotting its prey, the trumpetfish lunges and sucks a small fish into its tubular mouth.

A dusky damselfish (*Stegastes fuscus*) is doing the aquatic equivalent of pacing, nervously crisscrossing a patch of reef. Damselfish often protect algae patches from other grazing fish, effectively cultivating little gardens on the reef. Tenaciously territorial, it occasionally darts at fish much larger than itself and chases them off. It even nips at my hand and tries to take a bite out of the front of my camera housing. Nearby, I notice what looks like a bouquet of frilly pink flowers stuck in a coral head. Suddenly, it is gone. A closer look reveals a small opening in the coral formation, the end of a tube built by a burrowing worm. The feathery flowers actually are the tentacles of a fanworm (*Sabellastarte magnifica*) extended to filter plankton carried by the currents. They are highly sensitive to movement and withdraw so fast they seem to vanish.

You cannot describe coral reefs without waxing poetic in lyrical words that now seem trite. The simple fact is that a coral reef is a fantasyland abounding with myriad extraordinary creatures, where shimmering light plays across a wondrous landscape speckled with rainbow-hued fish. But the facts themselves seem no less fanciful. These are intricate and ancient ecosystems where anemones, sea stars, nudibranchs, cephalopods, crustaceans, sponges, reef fish, and an eclectic array of other creatures—including the corals themselves—live in complex relationships and in delicate balance.

Yet as I drift over the reef, a bleak truth overshadows its bright beauty. Coral reefs are rapidly being destroyed: Around the world, these primeval ecosystems are succumbing to the multi-pronged assault of climate change, pollution, overfishing, development, and other human activities that threaten their survival.

By 1998, about 11 percent of the world's coral reefs had already been destroyed, according to

TENTACLES OF A GIANT CARIBBEAN ANEMONE (*CONDYLACTIS GIGANTEA*).

CONCERNING CARIBBEAN CORAL

ROBERT RATTNER

The reefs of the Caribbean are relatively young: less than 20,000 years old. During the last glacial period, the waters of the Caribbean cooled, and its ancient corals died. Unprotected, the islands were battered by waves and the shoreline eroded, leaving underwater shelves or banks around them. As the seas warmed, corals returned, and reefs formed at the margins of these shelves—inspiring the name "bank barrier reef." These reefs are less extensive than barrier reefs, have shallower lagoons, and are found closer to shore.

Being the youngsters of the world's coral reef clan—Indo-Pacific reefs may be hundreds of thousands or even millions of years old—Caribbean reefs are home to fewer species than some reefs elsewhere. Still, more than 1,000 species can be found on some individual reefs. "The Caribbean is the richest area of species diversity in the Atlantic," notes Dan Brumbaugh of the American Museum of Natural History.

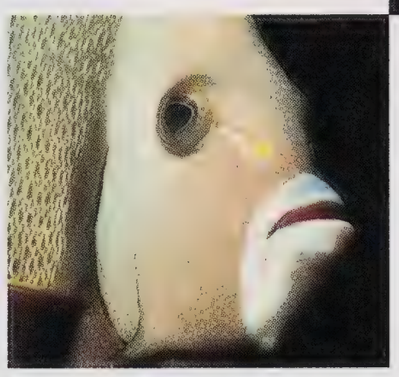
On land as well, the islands of the Caribbean—though mostly small in size—are home to a host of ecosystems and wildlife. Humid rainforests and arid desert scrub lie beyond the palm-fringed beaches that capture the minds and dollars of winter-bound northerners. The diverse and unique species found there—including an amazing array of land bird species found nowhere else on Earth, and one of the world's richest assemblages of reptiles and amphibians—prove that not all the islands' wildlife is found in beach bars.

The onshore and offshore ecosystems of the islands are inextricably entwined, and easily damaged. Growing human populations and the quest for economic development are taking their toll. More people need more food, but many of the shallow lagoons of the bank barrier reefs have already been overfished. As upland forest trees are cut to build new homes, and land is cleared to grow crops, valuable water catchment is lost. In Puerto Rico, just one percent of the island's historic rainforest is left. Tropical rains wash the newly loose soil, as well as pesticides and fertilizers, into rivers and streams. It all gets carried to the sea, where tides and currents distribute it onto coral reefs and sea grass beds.

Economic growth on many islands is tied to tourism. As ever more vacationers come seeking the sun, new resort hotels rise along the coasts. Their untreated waste often gets pumped into the sea. Boatloads of tourists visit the reefs and sometimes drop anchor, which is like letting a bull loose in a china shop—everything it touches will be destroyed. Throngs of snorkeling tourists bump into coral and kick up sand that settles onto the polyps. Scuba diving now brings considerable revenue to some islands, but a poorly trained diver can do even more damage than a snorkeler.

"The ecosystems are physically small and, therefore, particularly fragile," observes Rosemarie Gnam, assistant director of the Center for Biodiversity and Conservation at the American Museum of Natural History. "Proper planning and regulation of development is essential, or people will destroy the very thing they have come to enjoy."

EACH OF THESE REEF-BUILDING BOULDER STAR CORAL POLYPS (*MONTASTRAEA ANNULARIS*) IS AN INDIVIDUAL ANIMAL.



FROM LEFT: GRAY ANGELFISH (*POMACANTHUS ARCUATUS*); SPONGE BRITTLE STAR (*OPHIOTHRIX SUENSONII*); FEATHERED CHRISTMAS TREE WORM (*SPIROBRANCHUS GIGANTEUS GIGANTEUS*).

the Global Coral Reef Monitoring Network (GCRMN). Rising surface water temperatures, possibly due to global warming, worried scientists as well. Then the severe El Niño and La Niña hit. This weather cycle further warmed ocean currents and caused massive coral bleaching, a phenomenon in which increased water temperatures cause microscopic algae living within coral polyps to be killed or expelled, resulting in the coral polyps themselves whitening and usually dying. By the time the El Niño cycle had run its course, another 16 percent of the world's coral reefs had been lost. Some may eventually recover, but it could take half a century to do so.

If destructive activities affecting coral reefs continue, as much as 60 percent of the world's reefs could be gone within the next 30 years, according to GCRMN. These alarming predictions prompted the United Nations Environmental Programme to form a Coral Reef Unit, and for the UN Foundation to contribute $10 million to launch a major international cooperative effort to save reefs, called the International Coral Reef Action Network. Part of their plan is to create model sites around the world where reefs are protected and integrated with sound economic and social development, for coastal cultures often depend upon the sea's bounty, and in many places the reefs are the prime source of food for people.

These underwater realms also play an intricate part in the greater web of life. Coral reefs are home to one-fourth of all marine species, by some estimates, including about 800 species of hard coral and 4,000 species of fish identified so far. According to Dan Brumbaugh, marine program manager at the American Museum of Natural History's Center for Biodiversity and Conservation, estimating species diversity on coral reefs is difficult because few definitive studies have been done. "However, if extrapolations from research on several well-studied groups of reef species turn out to be true," says Brumbaugh, "the species diversity of many groups of smaller, less well-studied animals is actually much greater than currently estimated—perhaps by a factor of five to ten. Marine microbes are possibly underestimated by a hundredfold or more."

Found only in the tropics where water temperatures stay above 68° Fahrenheit, three basic types of coral reef exist: fringing reefs, barrier reefs, and atolls. A fringing reef abuts a landmass and forms when corals colonize rocks extending from shore. Barrier reefs, in contrast, lie offshore. They are separated from land by relatively shallow lagoons that stretch anywhere from several hundred yards to several dozen miles. At the far end of the lagoon, the reef rises to within less than two feet of the water surface and then drops off, often precipitously, to great

Damselfish often protect algae patches from other grazing fish, effectively cultivating little gardens on the reef.

ONCE A CORAL COLONY DEVELOPS INTO A REEF, A DIVERSE ARRAY OF SPECIES—INCLUDING SPONGES, ANEMONES, AND SEA FEATHERS—CONGREGATE TO CREATE RICH HABITATS FOR FISH AND OTHER MOBILE ANIMALS.

depths. Atolls form in the wake of a sunken volcanic island. These reefs grow along the perimeter of the submerging volcano, and sand accumulating on the coral creates a partial ring of islands encircling a central lagoon above the crater. The reefs of the Caribbean, however, are unusual "bank barrier reefs" that formed as a result of glacial activity within the past 20,000 years [see "Concerning Caribbean Coral," page 10].

Corals, along with sea anemones and sea pens, belong to a class of invertebrates called Anthozoa, which arose about 570 million years ago and today contains about 6,000 known species. Of these, about 2,500 species are hard or stony corals. Named for their rigid skeletons, hard corals—along with other mineralizing organisms, like some sponges and algae—are the major reef builders. (Not all hard corals build reefs, however.) Other types of corals have more flexible skeletons, and include gorgonians (such as sea plumes, fans, rods, and whips), black corals, and soft corals.

Even a reef hundreds of miles wide begins with just a single polyp, a coral animal that ranges from just 1/16th of an inch to several inches in size depending upon the species. A drifting planula—the polyp in its larval stage—will settle and permanently attach to the ocean floor. As it develops, the young polyp secretes a hard calcium skeleton, called a corallite, on which it lives. Its thin, soft body is like a tube with tentacles that extend outward to feed—usually at night—but, when withdrawn, becomes an almost imperceptible coating of living tissue over the corallite. The polyp grows by budding in place like a branching tree limb to create a connected coral colony. Once large enough, the coral colony may reproduce sexually, creating planulae and setting them adrift. Many corals, especially branching species, also propagate when pieces break off during storms and regenerate where they settle.

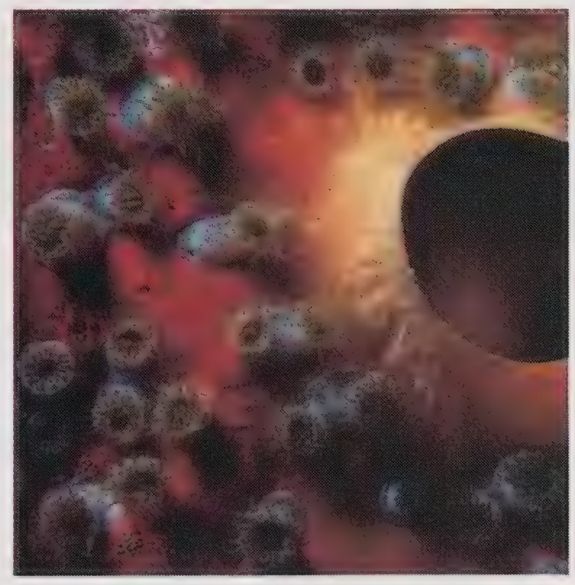
That first colonizing planula is like a pioneer discovering a New World. A settlement is built, and other migrants begin to arrive. Dispersing planulae often attach to the limestone skeletons of dead coral colonies and, over time, the tiny settlement becomes a massive marine metropolis hosting a melting pot of species. Generation after generation of coral communities, growing upon the remains of countless previous ones, have created the world's coral reefs. The largest, Australia's Great Barrier Reef, is more than 1,200 miles long and millions of years old.

While coral reef ecosystems are teeming with life, the tropical waters they inhabit are nutritionally poor. To compensate, corals have evolved elaborate systems which, like an orchestra, must perform in perfect harmony. Corals are efficient predators, using their tentacles to feed upon microscopic zooplankton in passing currents. Yet not nearly enough zooplankton exist in tropical waters to feed the mass of coral. Additional nutrition comes from microscopic algae called zooxanthellae that grow inside each polyp. The algae contain chlorophyll and convert sunlight into energy, supplying food and oxygen for the polyp. This symbiotic relationship also benefits the algae, which are well protected inside the polyp and get vital nutrients such as carbon dioxide and nitrogenous compounds from the coral's waste products. Since zooxanthellae require sunlight, reef corals grow in clear, relatively shallow waters. It is the loss of these zooxanthellae that causes coral bleaching.

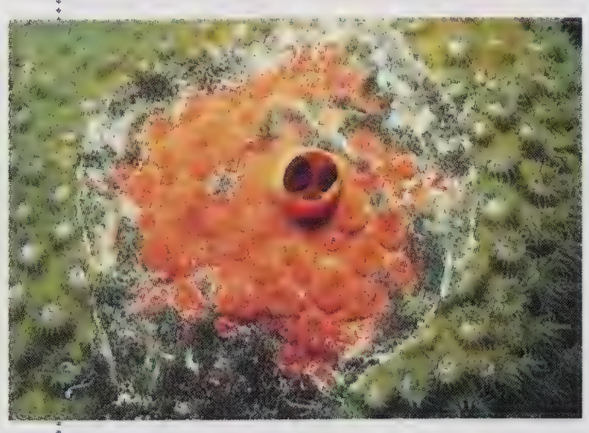
While climate change may pose the greatest problem to reefs in the long run, destructive human activities are wreaking irreparable havoc right now. Unlike bacteria and insects that can evolve in response to antibiotics and pesticides because they "live fast," Brumbaugh explains, reef-building corals' far longer life spans and slow rates of reproduction allow little chance for adaptive evolution to occur.

Overfishing and destructive fishing methods for food and the pet trade are causing the most severe damage to coral reefs today. Explosives are used to kill and catch fish, and cyanide is squirted into coral heads to stun hiding fish so they can be collected for home aquariums. Fish traps built for large fish often kill many smaller ones as well, and lost traps continue to lure and kill fish for many years. Such unsustainable fishing practices not only wipe out species on a reef but further upset the ecological balance. Serious overfishing in Jamaica—coupled with a die-off of sea urchins (*Diadema antillarum*), the other major algae grazer—left algae free to grow unchecked and to out-compete, and eventually eliminate, much of the live coral there.

GOOD NEIGHBORS?



A coral reef is like a crowded, bustling city where—for better or worse—residents often find themselves living in close quarters with each other. Relationships form between species, a phenomenon called symbiosis. Symbiotic relationships abound on a coral reef; the reefs' very existence is due to a symbiotic relationship—that between hard coral polyps and zooxanthellae algae. As with people, some species help each other out, while others take advantage of their fellow reef residents. If both parties get something out of the relationship, it is called mutualism. When just one gains but does no harm to the other, this is commensalism. And where one benefits but causes harm to the other, the relationship is parasitic.



The red boring sponge (*Cliona delitrix*) presents both extremes of symbiosis. It is an opportunistic parasite that attaches itself to corals (see left), then reproduces, expands, and kills the coral by dissolving away its skeleton. But the sponge also forms a mutualistic relationship with sponge zooanthids (*Parazoanthus parasiticus*), a type of colonial anemone that attaches to the red boring sponge but does not harm it (see above, right). Colonial anemones feed on microscopic creatures carried past them in the water. As the red boring sponge feeds by drawing water through its tiny surface openings, the anemones take advantage of the provender in the passing currents. The anemones return the favor by providing protection for the sponge. They are toxic to some sponge-eaters, such as angelfishes (family Pomacanthidae) and filefishes (family Balistidae), and their very visible colors may contrast with that of the sponge, possibly serving as a warning to the fish. Anemone-covered sponges often are the best survivors.

—Robert Rattner

Corals, along with sea anemones and sea pens, belong to a class of invertebrates called Anthozoa, which arose about 570 million years ago.

Many coastal communities could not exist without coral reefs. Natural breakwaters, the reefs buffer waves and surges rolling in from the ocean, protecting homes and preventing erosion. In the Maldive Islands, coral is harvested in huge amounts for building material. Low-lying islands there have suffered great damage from storms—damage that might have been mitigated had reefs been left in place.

Development on land directly affects coral reefs. Deforestation leads to the erosion of tremendous amounts of soil into the sea. Settling on a reef, the soil smothers coral and blocks sunlight from reaching the zooxanthellae. Dredging for boat channels further stirs up coral-choking sediment. Pollution is a growing problem, too. Freshwater and soil runoff can pick up toxic agricultural and industrial chemicals that are carried to the reef. And then there is untreated sewage, bilge waste, oil spills, thermal effluents...the list goes on and on.

Tourism generates further problems as well as revenue. Boat anchors being dragged across a reef obliterate swaths of coral. Divers and snorkelers frequently damage coral [see "Reef Etiquette," below] out of ignorance if not willfulness. On a dive in the Bahamas, I was hoping to photograph flamingo tongues (*Cyphoma gibbosum*), a leopard-patterned snail commonly found on sea fans. As sea fans undulate in the currents, polyps lining their lacy skeletons feed on passing zooplankton. Flamingo tongues eat the polyps but seem to do so at a pace that allows the polyps to regenerate. Usually, flamingo tongues are not hard to find. I

REEF ETIQUETTE

Without realizing it, many well-intentioned visitors—from novice snorkelers to experienced scuba divers—harm the very reefs they are admiring. By knowing some basic rules of the reef, you can avoid damaging fragile coral.

- **LOOK BUT DON'T TOUCH.** Do not break coral or collect anything from a reef. Do not stand on coral heads. Scuba divers should be careful when descending to avoid stepping on or brushing against coral. Not only are fragile coral polyps easily killed, damaged areas are susceptible to parasites and disease. At Garrafon Reef in Mexico, snorkelers must wear life vests—not just for their own safety, but to prevent them from diving down and knocking into coral. To remove the temptation of touching the sharp reef structures, snorkelers and divers at Anse Chastenet in St. Lucia aren't allowed to wear protective gloves.
- **AVOID STIRRING UP SAND AND SEDIMENT**—something very easy to do with your flippers—which can settle on corals and kill them. Snorkelers should float horizontally, keeping their feet off the bottom. Scuba divers should learn good buoyancy control.
- **USE YOUR CONSUMER CLOUT.** Before you go snorkeling or diving, ask about reef protection practices. Some of the worst damage to reefs comes from boat anchors being dropped and dragged over coral heads. Any place regularly visited by boats should have permanent moorings for boats to tie up away from areas with living coral. Dropping anchor directly on reefs should be strictly prohibited. In some places, dive operators have put in their own moorings, but it is essential that governments require it. Let tourist boards, dive shops, and hotels know that you will not visit unless they do not allow anchoring on coral reefs.
- **BE SURE YOUR CAPTAIN IS EXPERIENCED.** A lot of damage is done to coral by boats colliding with or scraping across the top of reefs, especially at low tide.
- **MAKE SURE THAT NO WASTE OR TRASH GOES OVERBOARD.**
- **BACK ON SHORE, DO NOT BUY SOUVENIRS OR OTHER PRODUCTS MADE FROM CORAL,** shell, or other reef life. Instead, consider buying other handicrafts, such as woven baskets, that help support local communities in non-damaging ways. Let tourist boards know that you consider how well countries protect their reefs when choosing where to travel.

—Robert Rattner

DIVERS CAN KILL CORALS MERELY BY TOUCHING THEM OR KNOCKING THEM WITH THEIR FLIPPERS.

THE VACUUM CLEANERS OF THE SEA, YELLOW TUBE SPONGES (*APLYSINA FISTULARIS*) DRAW WATER THROUGH THEIR TINY PORES AND FILTER OUT MICROORGANISMS FOR FOOD.

was in an area with a lot of sea fans, but I couldn't find any of the distinctive mollusks—until, back on the dive boat, I encountered a diver bragging about the "beautiful spotted shells" he had collected for his girlfriend. They would not remain so beautifully patterned for long. The colorful spots on a flamingo tongue cover a diaphanous mantle that the snail extends over itself but pulls in when threatened, ultimately leaving just a bare, peach-colored shell in a collector's now smelly dive bag.

Since that incident more than a decade ago, conservation and diver education efforts have increased significantly, but so have the stakes. We still don't even know all coral reefs have to offer. They may well be the pharmacies of the future. Life-saving medicines, such as the AIDS drug AZT—which was derived from chemicals in a Caribbean sponge—already are in use. Numerous other reef-derived remedies for serious illnesses currently are being explored. In fact, half of all new drugs being tested have marine origins, many from coral reefs. As we lose reefs, we also lose the possibility of ever finding these cures. And a coral reef destroyed is not easily replaced. These venerable edifices can only be created the old-fashioned way—one polyp at a time.

A FLAMINGO TONGUE (*CYPHOMA GIBBOSUM*) ON A SEA FAN (*GORGONIA* SP.).

Not long ago, I dove at one of my favorite places: Anse Chastenet, a resort in St. Lucia. As I swim from the beach, the sandy bottom slopes gently downward. At a patch reef before the drop-off, stoplight parrotfish (*Sparisoma viride*) browse on coral, and a spotted moray (*Gymnothorax moringa*) gracefully glides into a hole. I reach the ledge, and the bottom is suddenly gone.

At about 60 feet, I level off and follow the contour of the wall. Looking up, schooling fish arc around great corals and sponges against a backdrop of every possible shade of luminous blue. The reef seems so monumental and timeless that I can imagine the first European explorers sailing over these same coral heads. What's more difficult for me to imagine is that reefs that have survived for millennia could be gone in our lifetimes. Z

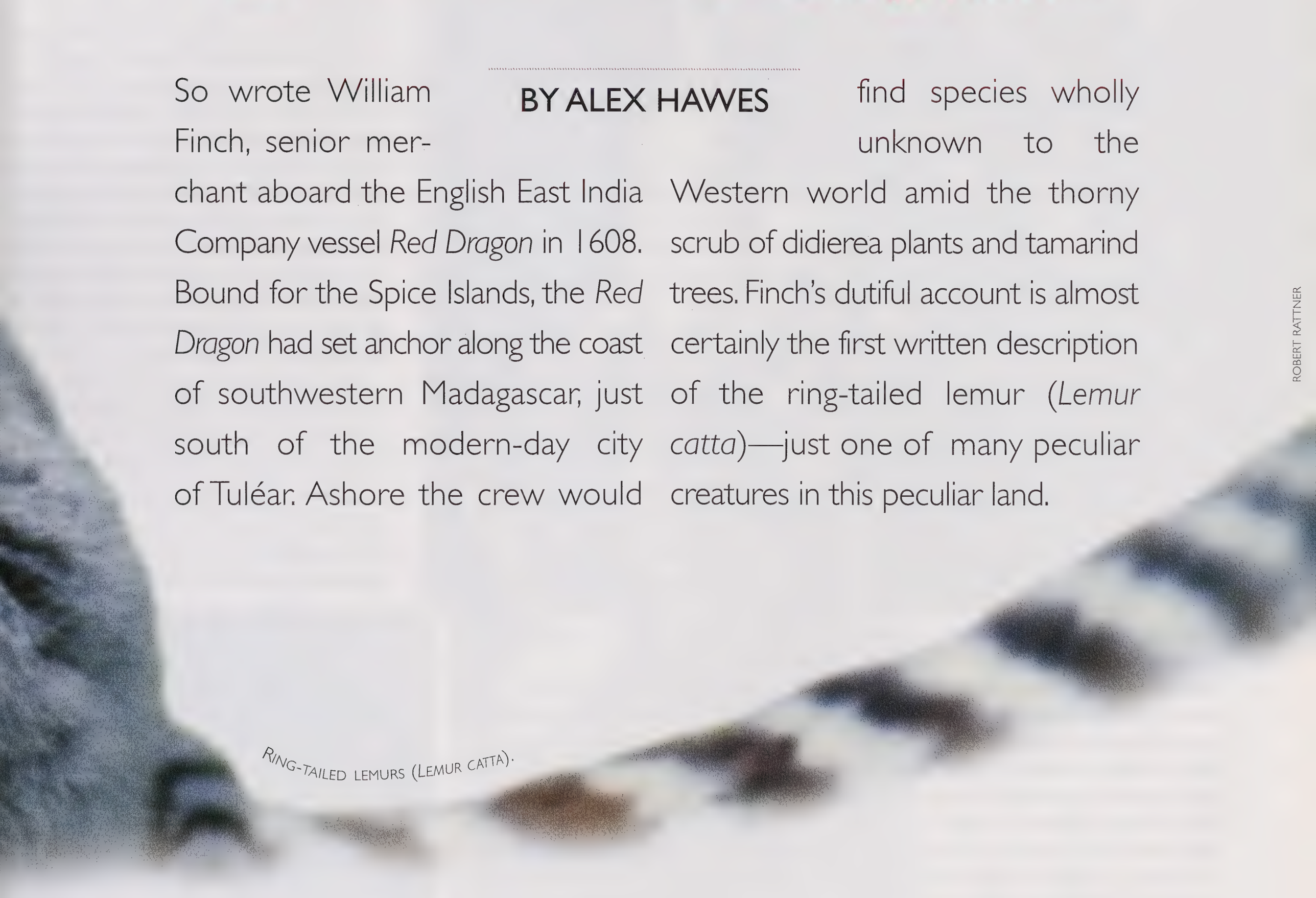
—Robert Rattner has visited more than 40 islands, on land and underwater, to document the people and nature of the Caribbean, and has also helped develop and implement wildlife conservation programs on several islands. His photographs and articles have appeared in numerous magazines.

AT THE ZOO: Ghosts

"In the woods neere about the River, is a great store of beasts, as big as Munkies, ash-coloured, with a small head, long taile like a Fox, garled with white and blacke, the furre very fine."

BY ALEX HAWES

So wrote William Finch, senior merchant aboard the English East India Company vessel *Red Dragon* in 1608. Bound for the Spice Islands, the *Red Dragon* had set anchor along the coast of southwestern Madagascar, just south of the modern-day city of Tuléar. Ashore the crew would find species wholly unknown to the Western world amid the thorny scrub of didierea plants and tamarind trees. Finch's dutiful account is almost certainly the first written description of the ring-tailed lemur (*Lemur catta*)—just one of many peculiar creatures in this peculiar land.



ROBERT RATTNER

RING-TAILED LEMURS (LEMUR CATTA).

# of Madagascar

ROBERT RATTNER

HIGHLY SOCIAL CREATURES, RING-TAILED LEMURS TYPICALLY LIVE IN GROUPS OF FIVE TO 30 MEMBERS.

It was from the lazy port city of Tuléar that I would journey eastward in a creaking jeep nicknamed *Manga-kelly* ("little blue") 385 years later on a far more modest expedition. I was accompanying a scientist studying Verreaux's sifakas (*Propithecus verreauxi verreauxi*)—white-furred lemurs that share the island's southern gallery forests with their smaller ring-tailed cousins. For hours on end, I would gaze up into the treetops to decipher sifakas' identities and movements, jotting down all bluffs and cuffs. It was but a sneak peak into their unique survival tactics.

While pitching a tent in front of the dusty research station the day of our arrival, I soon heard the grunts and car-alarm-like warning calls of Finch's curious creatures. Within minutes it seemed, a band of ring-tailed lemurs had descended upon our little clearing, the animals chomping at greens intended for the village's zebu cattle, drinking from a water bucket, and eying my tent—which I made sure was zipped tight thereafter.

As I crashed through the thorny forests of Beza-Mahafaly Special Reserve during the weeks to follow—waterproof notebook in hand, binoculars bouncing from my neck, my belly full from a dense breakfast of brown beans and rice—lemurs would appear from nowhere a few arm-lengths away. Ring-tails scurried across the trail, their banded tails pointed at the sky. Sifakas lunged through the air overhead or scared me senseless with their honking *seeee-fak* alerts and head-bobbing cautions. Quickly it was clear that I, the budding primatologist, was not the only one conducting observations. The ghosts of Madagascar were watching *me*.

The 33 known living species of lemur—from the Latin word for spirits of the dead (see "What's In a Name?" on page 30)—haunt only one place: the island nation of Madagascar (although populations of mongoose lemur, *Eulemur mongoz*, and brown lemur, *E. fulvus*, were introduced by people onto the nearby Comoro Islands several hundred years ago). The island's incredible diversity of life has evolved in creative isolation since Madagascar and the Indian subcontinent broke off from mainland Africa more than 120 million years ago. Palms, euphorbias, aloes, and more than 1,000 orchid species enrich the dwindling forests of this Texas-sized island. Six of the world's seven species of baobab tree spread their roots only here. All but two of the island's 150 known frog species and 90 percent of its reptiles—including two-thirds of the planet's 90 chameleon species— inhabit Madagascar, and Madagascar alone. In sum, an estimated 75 percent of all the flora and fauna here is *endemic*—unique to the island.

The remarkable array of lemur species further reveals the evolutionary cauldron that is Madagascar. Lemurs, together with lorises, galagos ("bushbabies"), and tarsiers, form the prosimian suborder—a branch of primates distinct from monkeys, apes, and humans (although the tarsier's exact position within the primate tree remains unclear). Fossil evidence

indicates that lemurs first appeared about 50 million years ago, well after Madagascar's separation from continental Africa. A founder population must have traversed the Mozambique Channel from Africa on floating vegetation or other debris—these bold colonists crossing a body

WITH LONG LEGS ADAPTED FOR LEAPING FROM TREE TRUNK TO TREE TRUNK, SIFAKAS BOUNCE ALONG AWKWARDLY WHEN EARTHBOUND.

ALEX HAWES

of water that is 220 miles wide at its closest point now, but was perhaps narrower and more riddled with intermediary islands then.

Ancestral lemurs flourished in the absence of large predators and primate competitors on Madagascar. The modern lemur species represent only a fraction of the diversity that existed here as recently as two millennia ago. Those that have since vanished—the so-called megalemurs—all greatly outweighed their surviving cousins. One such group, the palaeopropithecids, hung upside down from branches like orang utans or sloths with the help of long, arching finger bones. *Megaladapis* members likely clung upright to tree trunks while browsing on leaves—picture a 160-pound koala. The largest known megalemur (*Archaeoindris fontoynomtii*) tipped the scales at about 400 pounds, the size of a silverback gorilla, and stuck mainly to the ground.

The human occupants of Madagascar also descend from daring colonists. Sometime between 1,500 and 2,000 years ago, the ancestors of the Malagasy people first reached Madagascar, having traveled an astounding 4,000 miles from the Indonesian archipelago in simple outrigger canoes. Unfortunately for lemurs, these new arrivals introduced cattle and goats to Madagascar and hunted native animals for food. By the time European explorers and merchants like William Finch made records of the island's wildlife in the 17th century, all of the megalemur species had already vanished, as had two species of giant tortoise and several species of enormous elephant bird (*Aepyornis* spp.). Madagascar had suddenly become much smaller.

The island's diverse climate zones and microhabitats have allowed dozens of lemur species to co-exist through the eons. The southern end of the island features an arid climate with low tree canopies and entangling scrub vegetation. Dry forests and limestone plateaus reach northwards along the western coast of Madagascar, while the eastern coast bears a narrow band of lowland rainforest containing a rich assemblage of plant and animal species. Mountains up to 9,000 feet in elevation dot the interior of the island, where lush highland rainforests have all but disappeared since the advent of agriculture. In their place sit terraced rice paddies and cattle pastures. Amid the deforestation and development, Madagascar's wild creatures must apply adaptations evolved over millions of years to an altered landscape presenting novel obstacles to survival.

The lemur species today range in size from the pygmy mouse lemur (*Microcebus myoxinus*)—which, at less than two ounces, is the smallest of any primate—to the indri (*Indri indri*) and the diademed sifaka (*Propithecus diadema diadema*), which each weigh upwards of 16 pounds. I use the term "lemur" loosely to refer to all primate species on Madagascar—including those within the Lemuridae family (the "true lemurs," such as ring-tailed lemurs and brown lemurs), as well as the Indriidae (the woolly lemurs, sifakas, and indri), Lepilemuridae (the gentle and sportive lemurs), Cheirogaleidae (the dwarf and mouse lemurs), and Daubentoniidae (whose lone member is the bizarre aye-aye).

Most lemurs feed primarily on leaves and fruit, as well as sap, gum, and nectar. The mainstay of the ring-tailed lemur diet is the pod of the kily (*Tamarindus indica*), a common tree in their arid home. Not surprisingly, bamboo lemurs (*Hapalemur* spp.) prefer bamboo shoots and leaves, while the aforementioned aye-ayes (*Daubentonia madagascariensis*)—which resemble some strange Steven Spielberg/George Lucas creation—use long middle fingers and protruding incisors to dig up insect larvae that they've detected in tree bark, thanks to the auditory powers of their giant ears.

While all prosimians evolved from nocturnal ancestors and still retain certain nocturnal adaptations—including a strong sense of smell and keen vision at night—several lemur species lead either diurnal (active during the day) or crepuscular (active mainly at dawn and dusk) lives. The hours a species keeps can affect, or be affected by, the social system its members maintain. Primates that live in large groups are,

ROBERT RATTNER (2), ALEX HAWES

FROM LEFT: RED RUFFED LEMUR (*VARECIA VARIEGATA RUBER*), BROWN LEMUR (*EULEMUR FULVUS*), AND VERREAUX'S SIFAKA (*PROPITHECUS VERREAUXI VERREAUXI*).

JESSIE COHEN/NZP

BLACK AND WHITE RUFFED LEMURS ARE GRADUALLY LOSING THEIR LOWLAND RAINFOREST HABITAT TO AGRICULTURAL DEVELOPMENT.

without exception, active mainly during the day—maintaining a cohesive social structure in the dark is inherently difficult (if not impossible) for animals that rely on visual communication. The lemur species that live in groups of up to ten or more—ring-tailed lemurs, brown lemurs, and sifakas, for example—thus are all diurnal. Conversely, the mouse lemurs and dwarf lemurs, which can fall victim to a host of mammal and bird predators by virtue of their hamster-like size, prefer the safety of nighttime travel and live either alone or in small family groups.

What most clearly distinguishes nearly all lemur species from their typical primate brethren is their social chain of command: Females dominate. In these species, female lemurs have preferred access to the choicest fruits and appear to dictate group movements (see "Mandrills are from Mars, Lemurs are from Venus," in the January/February 2000 *ZooGoer*). After weeks observing the drama unfolding in the treetops of Beza-Mahafaly, it was clear to me that female lemurs there were running the show. Moreover, sifaka matrons seemed benign rulers—the obedience of their male comrades is generally attained without incident—while their ring-tailed sisters tyrannically enforced their preeminence. Lemur biologist Alison Jolly of Princeton University writes about ring-tails: "at any time...a female may casually supplant any male or irritably cuff him over the nose and take a tamarind pod from his hand." A not-so-gentle reminder of who's in charge.

Known to the local Malagasy as *maki*, the ring-tailed lemur serves as a widely recognizable symbol of Madagascar's diverse wildlife. The abundance of ring-tailed lemurs at reserves like Beza-Mahafaly—and in zoos the world over—masks a growing threat, however. Satellite data have shown that their spiny forest habitat is being slowly consumed by overgrazing livestock, fires, and the cutting of trees for charcoal. There remain anywhere from 10,000 to 100,000 ring-tailed lemurs on Madagascar according to a survey published in 1992 by the World Conservation Union (IUCN), which now considers this species vulnerable to extinction.

More than 90 percent of all of Madagascar's native forests have already been destroyed by slash-and-burn cultivation and large-scale farming. The country's human population, a vibrant blend of African and Asian influences, faces persisting poverty and an ever-shrinking natural resource base. Many of the ethnic groups here, however, have long considered killing lemurs to be *fady*—taboo.

"I was in Tattersall sifaka [*Propithecus tattersalli*] country four to five years ago," recalls Russell Mittermeier, president of Conservation International and chairman of the IUCN/Species Survival Commission Primate Specialist Group. "This forest area was just overrun with gold miners living in wretched conditions, on the verge of starvation. But every afternoon, these little sifakas would come bouncing into camp and would be fed bananas by the miners, and then they'd bounce away. So some *fadys* are still holding." Yet, in other areas of the island, taboos against killing lemurs appear to be eroding within a slowly modernizing, but still destitute, Malagasy society.

The troubled status of lemur populations on the island carries grave implications for other segments of their respective ecosystems. Jörg Ganzhorn of Hamburg University has found that the dry forests of western Madagascar contain few seed-dispersing animals. About ten percent of the tree species there rely largely or completely on lemurs—especially brown lemurs—to ingest, excrete, and thereby disperse tree seeds. Certain lemur species, such as the black lemur (*Eulemur macaco*), also help pollinate flowers. The healthy regeneration of already degraded forests may not be possible without lemurs present.

Like giant pandas, lemurs further serve as "flagship" species highlighting the threats to their habitat and to the reptiles, amphibians, plants, and other equally imperiled but less recognizable species that live there. Ecotourism largely based around primate-watching represents a growing share of Madagascar's economy and a stimulus for land conservation. Russell Mittermeier predicts tourism will become the country's number one source of income within the next decade. "You can see more primate species in a week in Madagascar than in six months in the Amazon," says Mittermeier. (Those interested in voyaging to the land of lemurs can find listings of responsible tour operators from the nonprofit International Ecotourism Society online at www.ecotourism.org.)

Not everyone can manage a trip to the Indian Ocean. Inquisitive lemur watchers, however, will soon find a mixed troop of nine ring-tailed lemurs and two red-fronted lemurs (*Eulemur fulvus rufus*) on the Smithsonian National Zoo's Lemur Island (formerly Monkey Island). The Zoo's new prosimians hail from the Duke University Primate Center, an institution that is leading experimental efforts to reintroduce black and white ruffed lemurs (*Varecia variegata variegata*) into the wild.

These newcomers are sure to delight zoogoers with their complex social conduct and acrobatic antics. So come gaze through binoculars, telephoto lenses, or your naked eyes at an evolutionary treasure in our midst.

But you'll have to bring your own rice and beans. Z

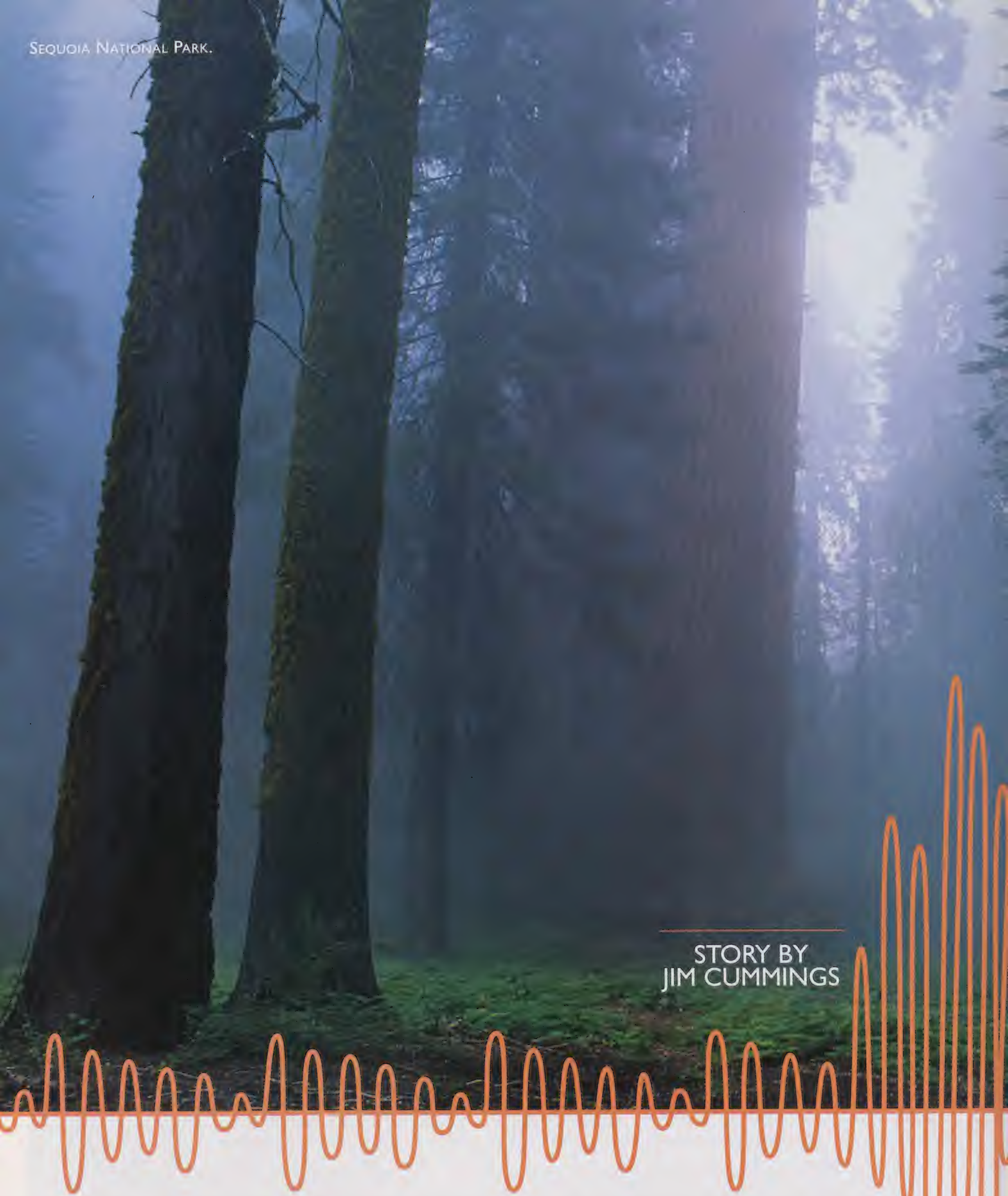
—Alex Hawes is Associate Editor of ZooGoer.

Life has evolved in creative isolation since Madagascar and the Indian subcontinent broke off from mainland Africa more than 120 million years ago.

The zoo is going to be a zoo.

Parking will be a bear. Make sure you take Metro. Just hop on the Red Line and take Metrorail to the Woodley Park-Zoo/Adams Morgan station or the Cleveland Park station. Both the L1 and L2 Metrobuses stop at the Connecticut Avenue entrance, while the H2 Metrobus goes to the Harvard Street entrance. Visit Metro's Ride Guide at www.metroopensdoors.com or call (202) 637-7000.

M metro opens doors



SEQUOIA NATIONAL PARK.

STORY BY
JIM CUMMINGS

In the forest or on a city street, sounds bring the world alive. Whatever beauty or complexity, pattern or structure we might see around us, the world would be stark beyond recognition if we could not hear all that lies beyond our sight, hidden around corners or behind the screens of people or trees. The subtle voices of birds quietly chirping their territorial presence can fill a hillside, with an occasional outburst from the middle distance letting us know that crow, or chipmunk, is also nearby. These sounds can call us out of ourselves, so our awareness expands to know the land a little more fully, more intimately.

Listen Up!

Opening Our Ears to Acoustic Ecology

As technological civilization diminishes the biotic diversity of the earth, language itself is diminished.... For when we no longer hear the voices of warbler and wren, our own speaking can no longer be nourished by their cadences. As the splashing speech of the rivers is silenced by more and more dams, as we drive more and more of the land's wild voices into the oblivion of extinction, our own languages become increasingly impoverished and weightless, progressively emptied of their earthly resonance.

–David Abram, THE SPELL OF THE SENSUOUS

PHOTOS BY ALEX HAWES

As our world becomes ever more dominated by the sounds of humans and our machines, the subtle beauty of nature's voices becomes ever more precious. A fascination with the voices of nature, as well as the soundings of humanity, fuels the emerging field of "acoustic ecology." This umbrella term encompasses work being done by academics, city planners, sociologists, activists, and sound artists, each in their own way encouraging a deeper appreciation for sound and its role in our lives.

Acoustic ecology looks at the relationships that creatures develop through sound, and at the ways that humans and other

Sunrise over Joshua Tree and Great Sand Dunes (below) brings an awakening of natural sounds to protected lands often buzzing with cars and planes.

animals are affected by their sonic environments. Some of this work is research-oriented, such as that pursued in the field of bioacoustics. Others turn to more subjective pursuits, such as teaching "deep listening" or forging new kinds of compositions created from field recordings. And some have taken up the cause of sound, championing the acoustic right of nature to be free of human noise.

A small item appeared on the wire services last year. According to the Royal Society for the Protection of Birds, the populations of finches, warblers, and orioles in London are in rapid decline. City noise seems to be interfering with their ability to learn the mating calls of their species; rather than a melodious song, some youngsters can only manage a generic sort of chirp. Is this a sign of things to come?

Opening Our Ears: Learning to Listen

Pause for a moment, and listen. What is the dominant sound? Explore the components of the background ambience you are immersed in. Listen a bit longer—let a minute or two pass. Has there been a change? Did any fleeting soundmakers come by?

You are hearing the voice of the planet, as it is manifest in your immediate surroundings. In this hour, as Earth spins in the sun, each place is contributing its share of this great sounding whole. A twilight chorus of peepers and poorwills; mid-morning breezes in forests of fir; seals under arctic ice calling out like otherworldly sirens; the whine of a semi cresting a mountain pass; a desert marketplace alive with the calls of children, donkeys, and music; a waterfall roaring in the forest, witnessed by no human ear; and the voice you hear now—all live together in the eternal, ever-changing moment of a sounding planet.

It can sometimes seem that the urban cacophony, combined with the near omnipresence of radio and TV chatter, has led us to "close down" our ears, or to selectively filter what we allow into our awareness. If so, when we turn our ears once again outward to the world, we may be starting with diminished sensitivity, and have difficulty at first "tuning in" to the sounds and patterns of the natural world's voice. Certainly our auditory acuity and conceptual subtlety lags far behind that of most primal cultures. In books and audio CDs, New York University anthropologist Steven Feld has explored the rich variety of ways in which the Bosavi people of Papua New Guinea experience the sounds of the rainforest that is their home. "It's an interlocking soundscape," says Feld. "Sounds tell the time of day, season of the year, conditions of the trails. Songs reflect all these interlocking sound clocks; they are maps of the forest." In hunting, music, ceremony, and language, nature's voice makes its mark on human culture. Perhaps the most ineffable sonic lesson learned from primal cultures, one that has seemingly been discarded by industrial society, is that human language, music, and communal soundmaking are but one part of a larger, ongoing "song" of our home places. Listened to with this awareness, it is remarkable to hear the "natural" quality of the individual and social human voice in such a context.

Answering the need for some re-tuning of our ears, several programs have emerged in recent years to encourage closer attention to listening. At the Olympic Institute in Washington State, Gordon Hempton runs annual workshops that aim to make the act of listening come alive in wild landscapes. As Hempton says, "Listening is a creative act with an audience of one." He encourages active exploration of the soundscape, urging participants to move about in a given place, exploring different "mixes" of sound, seeking spots that come alive, where the balance

> "Listening is a creative act with an audience of one."

of sounds is especially vivid, or where a sound is obscured and so transformed in interesting ways. Leaves, trees, or our own hands and bodies can all become elements used to affect the soundscape we experience. Hempton is fascinated by ways that sound is changed in nature, such as when a resonance is added to the sound of surf when heard from within huge driftwood logs on a beach. To those who find joy in listening, nature offers a ceaseless symphony of sound, with infinite possibilities for engagement and exploration.

This active, engaged approach to listening is echoed by the practice of "soundwalking." In workshops and classroom settings, soundwalks offer a first reminder of listening. At its simplest, a soundwalk is just what its name implies: a walk during which you simply pay attention to each sound you encounter. More complex variations can include seeking out the most distant sound audible, or the faintest. Soundwalks are just as interesting in cities as in nature, and indeed, urban acoustic ecology offers many points for reflection and even aesthetic appreciation.

"During a soundwalk," says Andra McCartney, professor at Concordia University in Montréal, "I pay attention to the sounds in my environment with the same focus and awareness that I use to listen to music, or to the sound of my lover's voice. Like many simple experiences, soundwalking is often profound as well. The act of focusing on that moment, that place and time, leads me to hear that place differently, to understand it in new ways."

Acoustic Activism

Acoustic ecology emerged as a defined field during the 1970s at Simon Fraser University in British Columbia. There, a cross-disciplinary mix of philosophy, sociology, and art gave rise to the World Soundscape Project (WSP). Led by writer and composer R. Murray Schafer, WSP participants collected recordings of urban "soundmarks" such as noon whistles, harbor horns, and train station ambiences, documented natural soundscapes and tribal history, and conducted interviews to discover how people react to various sorts of sounds encountered in their daily lives. Perhaps the most influential (and controversial) idea to come out of this early work in acoustic ecology was the idea that natural soundscapes can be characterized as "hi-fi" acoustic environments, while most human sounds, by contrast, are "lo-fi." The analogy to audiophile terms is quite direct: Lo-fi soundscapes are characterized by distortion, broadband noise, and discomfort, while hi-fi natural soundscapes tend to be sound balanced, aesthetically rich, and pleasing to the ear.

As ideas such as these spread, one of the first places they had concrete impact was in city planning. While, to a large degree, city sound ordinances were developed to limit dangerously loud sounds and block housing areas from highway noise, the value of open space and parks as sonic refuges has become part of the urban planning mainstream.

In wildland areas, acoustic activism has increased as the ability to retreat from human sounds has diminished. Gordon Hempton is one of many natural sound recordists who have experienced a dramatic decrease in the amount of time he can record without having a human noise (most commonly an engine) intrude. Between 1984 and 1989, the number of locations in Washington State where he could record for 15 daytime minutes without interruptions by human noise intrusions dropped from 21 to just three. Walking with Hempton in his beloved Olympic National Park, a companion might be startled by a sudden grimace—his sensitive ears have picked up a distant airplane, breaking the spell of the wild and initiating a gentle torrent of policy prescriptions from this devotee of listening. "Earth is a musical planet, spinning in silent space," he says. "However, the acoustic environment has not received adequate protection. The music of nature and the quiet opportunity to enjoy it are threatened by the noise of man."

There is beginning to be more acknowledgement of the importance of the "sound resource" among park administrators. "Natural sounds are part of the special places we preserve. Rustling winds in the canyons and the rush of waters in the rivers are heartbeat and breath of some of our most valuable resources," says former National Park Service Director Robert

CRASHING WATERFALLS AND GURGLING STREAMS ADD RICH TEXTURE TO FOREST SOUNDSCAPES.

"Earth is a musical planet, spinning in silent space."

Stanton.

Airplane overflights of national parks is the most recognized issue being championed by environmental advocates of natural quiet. In Grand Canyon National Park and Rocky Mountain National Park, sound studies have contributed to the establishment of new, more limited flight patterns for tourist aircraft. Biscayne National Park in Florida is the first park to take Hempton's call for system-wide acoustic inventories to heart. In 1999, this park's staff began working toward a comprehensive Soundscape Management Plan. Public comments were gathered, and the final plan is expected later this year.

A major source of human noise on public lands is personal recreational vehicles. "As snowmobiles, all-terrain vehicles, and jet skis expand into new areas and seasons of the year because of greater speeds and capabilities, they create new conflicts. They have more impacts on the natural world and the human enjoyment of it," says John Gatchell of the Montana Wilderness Association. Over the past two years, the National Park Service has introduced new regulations limiting, and in some cases banning, the use of such vehicles.

Personal watercraft have been the most severely regulated, with a full ban on jet skis taking effect last summer in most national parks (including Biscayne). In addition to 19 national parks, seashores, and scenic rivers where personal watercraft are now banned, 21 national recreation areas, national seashores, and similar sites managed by the Park Service are under a two-year grace period. After this, personal watercraft will be banned unless authorized by special regulations that include a full environmental impact and public comment process.

Meanwhile, snowmobile use is also facing increased regulation. During the past decade, a new generation of more powerful snowmobiles has been developed. These new machines can handle more rugged backcountry terrain than snowmobiles of old, leading to a marked increase in snowmobile noise in remote areas of national forests and parks. At Yellowstone, it is not uncommon for a thousand snowmobiles to be buzzing through the landscape; although they are confined to roads and trails, their sound is heard for miles. Last winter, Yellowstone and Grand Teton national parks announced that snowmobiles would likely be totally banned by the winter of 2002-3. Though this plan is facing tough opposition from local businessmen and governments, the Park Service rejected an earlier plan of phasing in quieter, cleaner machines over ten years, saying that it did not meet the park's legal obligation to protect the environment. Similarly, Rocky Mountain National Park announced in December that its preferred management alternative is a total ban of snowmobiles; public comments are being accepted through March and a final rule is expected to be announced by early 2002.

A similar, though more modest, shift is taking place in the regulation of all-terrain vehicles (ATVs). Here, the emphasis has been less on national parks and more on Bureau of Land Management and state lands, many of which have become weekend hotspots of motorized recreation. The trend is toward corralling ATV use into prescribed but still wide-ranging areas, leaving more land available for quiet forms of recreation.

It's not only off-road and motor-sports vehicles that are being banned from parks. Utah's Zion National Park is the first to completely ban private autos from most of its roadways. Other parks (including Acadia, Grand Canyon, and Yosemite) have instituted optional shuttles, but in Zion all visitors must park and ride. Responses from visitors have been overwhelmingly positive, with most citing the joys of experiencing the otherworldly beauty of Zion's cliffs without the all-too-familiar drone of engines. As one visitor enthused, "It's absolutely fantastic to be up in Zion Canyon again—you can actually hear the birds singing."

You may have noticed that most of the activity taking place in national parks and other public lands is inspired largely by the desire of other humans to enjoy the natural soundscape,

TRUE SILENCE IS RARE ON OUR MODERN PLANET.

rather than out of concern for the effects of human noises on wildlife. In the most recently emerging area of acoustic activism, the priorities are reversed: For activists focusing on sounds in the seas, the emphasis is squarely on the acoustic rights and needs of wild creatures.

By far the most dramatic issue being addressed in the oceans is the development of a new generation of underwater surveillance technology. The U.S. Navy, in collaboration with allies, is in the testing phase of the Low Frequency Active Sonar (LFAS) system. Using powerful sound waves, LFAS is designed to monitor undersea activity by enemy submarines. With sound as loud as 240 decibels, these systems are planned to permeate 80 percent of the world's oceans. At peak output, the sound would still be at 120 dB as far as 250 miles away from the source; many fish and whales start avoiding sounds when they reach 120 dB. During tests over the past several years (using source output levels much lower than those planned when the system is implemented), the Navy and its contractors have been looking at the effects of the tests on local marine life, most notably cetaceans (whales, dolphins, and porpoises). In the view of LFAS supporters, the results show minimal behavioral disturbance, but acoustic activists following the issue disagree strongly.

In Hawaii, during studies in 1998 and 1999, independent monitors reported that migration patterns of gray whales (*Eschrichtius robustus*) shifted away from testing areas, while vocalizations of several whale species diminished significantly. More alarming, in the spring of 1998, observers with the Ocean Mammal Institute discovered two abandoned whale calves and a baby dolphin in the testing area. "We have never heard of anyone observing an abandoned cetacean calf in nine years of research," states a report by the OMI's Marsha Green.

In March of 2000, a dramatic beaching incident in the Bahamas provided further fuel for LFAS opponents. While testing of a lower-power mid-frequency active sonar system was going on nearby, seven whales beached and died. Autopsies reported by the National Oceanic and Atmospheric Administration revealed that six of the dead whales had experienced "injuries consistent with an intense acoustic or pressure event," including hemorrhages in or around the ears. In the wake of these and other questions, including objections from two federal agencies, tests scheduled for May 2000 in the waters off New Jersey were cancelled, pending further study, while the Canadian Navy committed to conduct tests only when there were no cetaceans in the testing area.

Soundscape Art

In the 1970s, environmental sound recordings first made a splash in popular culture, spearheaded by Irv Teibel's *Environments* series. These LPs featured rich, un-narrated ambiences of specific habitats, recorded and reproduced with state-of-the-art stereo technology, creating a compelling listening experience. When Roger Payne's *Songs of the Humpback Whale* became a best-seller, the doors were opened for a wave of natural sound releases, most of which were close variations on the *Environments* formula.

During the 1990s, a new generation of soundscape producers emerged who are stretching the bounds of the genre in exciting new ways. Some have built on the foundations of traditional nature sounds pioneers, presenting portraits of specific habitats, while developing highly individual approaches. For example, Lang Elliott is known for stunning close-up recordings of birds, as well as his series of habitat titles that feature similarly amazing close-up recordings of rich sound communities. Jonathon Storm, by contrast, specializes in the subtle variations in water's voices and the soft natural quiet of forest landscapes.

Meanwhile, other producers have emerged from acoustic ecology circles. Their CDs are more apt to include sonic essays that explicitly raise questions about humanity's relationship to natural and urban landscapes. Hildegard Westerkamp is perhaps the best-known of these producers, creating works for radio, public performance, and CD that range from sparsely narrated "soundwalks" to multi-layered productions composed purely of field recordings that pull the listener deeper into the world of sound.

And several producers, such as Germany's Michael Rüsenberg and America's Douglas Quin, have built on composer John Cage's notion that all sounds can be considered elements for composition. Not surprisingly, the works emerging from this diverse community vary widely,

Morning mist in Crested Butte, Colorado.

People are slowly learning to appreciate—and protect—the auditory as well as visual magnificence of national treasures like Canyonlands.

from portraits of specific cities (Lisbon, Rome, Vancouver) to finely honed compositions that use nature's voices as a central element (such as Quin's CD-length work *Forests: A Book of Hours*).

The individual voices of today's soundscape artists reflect the genre's emergence as a full-fledged creative medium, much as photography blossomed in the early 1900s. In both fields, a documentary medium was enlivened by artists who explored new perspectives, subject matter, social content, and innovative studio techniques. As with photography's birth as a creative art, which began in Europe's avant garde communities, soundscape art has been a growing presence in experimental gallery circles since the 1960s and today stands poised for widespread attention and appreciation.

The Voice of the Planet

Underlying the work of all the people mentioned here is a passion for listening deeply to the voice of the planet. Our awareness of—and engagement with—this sounding whole is yet another of the nurturing connections that we've gradually forsaken over the past decades and centuries. It has slipped only slowly away, so slowly that we've hardly noticed its passing. While we've forgotten our place as one voice in a community of sound, we've also borne witness to the eclipsing of nature's communal voice by the increasingly dense web of human machine-made noise.

As acoustic activists raise a voice for the sanctity of natural quiet, and sound artists act as sonic shamen, re-tuning our collective ears to listen more consciously to the world around us, we are offered opportunities to re-connect with the ceaseless symphony that awaits just outside our doors. Of course, in the real world, it's not all that dramatic—it's simply about letting sound expand our awareness, both in the practical sense of revealing actions and beings that are not visible from where we are, and in the more ineffable way that attention to sound can seem to make us more present in a place. Let me share a bit of what I mean.

I live in a small canyon. In the span of about five miles, it connects a mixed conifer forest in the lower reaches of the Rocky Mountains with the high desert of the Galisteo Basin. This afternoon, I strolled up a side drainage behind our house. We're in the last vestiges of winter, the nighttime frosts getting less frequent and harsh. Soon the nights will blossom with sound.

But today, the sounds of the meadow and its surrounding hills are subtle. The voice of the planet, as expressed in this here and now, includes a handful of birds scattered around the periphery, the occasional close encounter with a fly, an airplane several miles off, and some neighborhood dogs carousing down the canyon. Meanwhile, the clouds roll silently into sight above a ridge to the west. Ah, but not so silent, as nearby eddies of Earth's breath sing gently in the piñons that grace the slopes embracing this meadow. Now the trees of the eastern ridge come alive, roaring in the leading edge of a strong gust of wind. For 30 seconds, I follow the sound up the ridge, as it surges and wanes, adding layer upon layer of subtly varying tones while the trees roll and shimmer, until at last the gramma grass around my silent feet bursts into dance and I, too, am immersed in the rush of air passing by.

The longer I stay, the more my ears and eyes open, the more the place draws me out of myself. Swirling clouds of grass and weed seed, mixed with a few small insects, are swept along in the waves of wind. The grasses whisper, occasionally eclipsed by the roaring of a breeze caught swirling in my ears. Peripheral sounds shift subtly, yet dramatically, as wind, birds, and a train come and go. Kids play a hundred yards away. And still the clouds soar past, distant contacts with the great currents of the sky, whose edges whisper through my hair.

These moments of sonic, visual, and tactile presence inspire me with a more expansive sense of self, one that encompasses the valley as a whole. Relationships of interaction, exchange, and co-evolution become palpable, and I feel my place in this greater context. It is from this ground that I occasionally catch a glimpse of an ancient and ever-new story, told in the original language. Z

—Jim Cummings is a father, writer, and founder of EarthEar, a collaborative project involving many of the world's leading soundscape producers. He lives in the upper Rio Grande watershed among the foothills of the southern Rockies.

Contacts

World Forum for Acoustic Ecology. An extensive collection of writings and links to organizations around the world.
http://interact.uoregon.edu/MediaLit/WFAEHomePage

EarthEar. A new record label-cum-catalog company, based in Santa Fe, that has begun championing the full range of creative soundscape styles. EarthEar's web site includes acoustic activism news, essays on soundmaking and listening, and an Educators' Resource Center.
www.EarthEar.com; info@earthear.com; tel. 888.356.4918

Noise Pollution Clearinghouse. A national organization that works to reduce urban noise pollution and to protect natural quiet, maintaining extensive online resources on health and policy issues.
www.nonoise.org; tel. 888.200.8332

ROBERT E. MUMFORD, JR., NATURAL IMAGES PHOTOGRAPHY

BOOKS, NATURALLY

ZooGoer *presents its annual summer sampler of fiction books that pack an environmental punch:*

***Purgatory Ridge.* William Kent Krueger. 2001. Pocket Books, New York. 352 pp., hardbound. $23.95.**

Mill operator Karl Lindstrom plans to save his floundering lumber business by logging the ancient white pines the Ojibwe Anishinaabeg call *Ninishoomisag*—Our Grandfathers. When a propane tank at Lindstrom's mill is blown up, and his wife, Grace Fitzgerald—heir to the Fitzgerald Shipping Company fortune—is kidnapped, there are more suspects than trees in the forest.

Despite the conflict over the sacred white pines, many of the Anishinaabeg work as loggers and depend upon Lindstrom's business for their own livelihood. So perhaps the culprit instead is one of the environmentalists who have descended upon the small Great Lakes town to protest the logging. Or could Lindstrom's sole neighbor—who lost his brother when the Fitzgerald ship, the *Teasdale*, went down, and lost his privacy when Lindstrom built his spacious log cabin across Grace Cove—have a vendetta against Lindstrom and Fitzgerald?

Purgatory Ridge, Krueger's third novel in his "Cork O'Connor" series, is a top-notch mystery, with enough twists and turns to keep you white-knuckled. At the same time, Krueger's characters are complex and believably flawed. Unlike books in many mystery series, *Purgatory Ridge* reads like a solo novel, without excessive references to previous storylines, but with a satisfying ending that will make you thirst for the next installment.

—*Sue Zwicker*

***Field Guide.* Gwendolen Gross. 2001. Henry Holt and Company, New York. 275 pp., hardbound. $23.**

An American grad student studying fruit bats in the jungles of Queensland, Australia. Her enigmatic advisor vanishing into the wilderness. The son returning home from the States to search for his lost father. These storylines converge in compelling if somewhat unsurprising ways in Gwendolen Gross's first novel, *Field Guide*.

Gross herself spent a summer mucking about Australia's rainforests observing spectacled fruit bats, and her knowledge of the rush—and daily humdrum—of scientific exploration enlivens the narrative. Field research comes across as positively kinky: "Annabel watched him from the water when she came up from the clams. His face was intent—the deep sleep of absolute concentration—and it made him beautiful to her. He had the glow of intimate observation, and she longed to have that attention directed at her."

The book stirs a satisfying blend of natural history, suspense, and romance, shifting gears and hopping continents, while the primary plot—the disappearance of Professor John Goode—plods along. As in *Purgatory Ridge*, tension between environmentalists and loggers factors into the mystery. The grad student heroine, Annabel Mendelssohn, returns to camp one day and finds her bat subjects driven off by anti-environmentalists; could they have done harm to the dear Professor? Ultimately, however, Gross opts not to push the throttle on the thrill but rather focuses on charting the characters' emotional journeys. The reader may find the story's final destination unsatisfying, but the ride is well worth it.

—*Alex Hawes*

***Pavilion Key: Isle of Buried Treasure.* Greg Lewbart. 2000. Krieger Publishing Company, Malabar. 200 pp., hardbound. $18.50.**

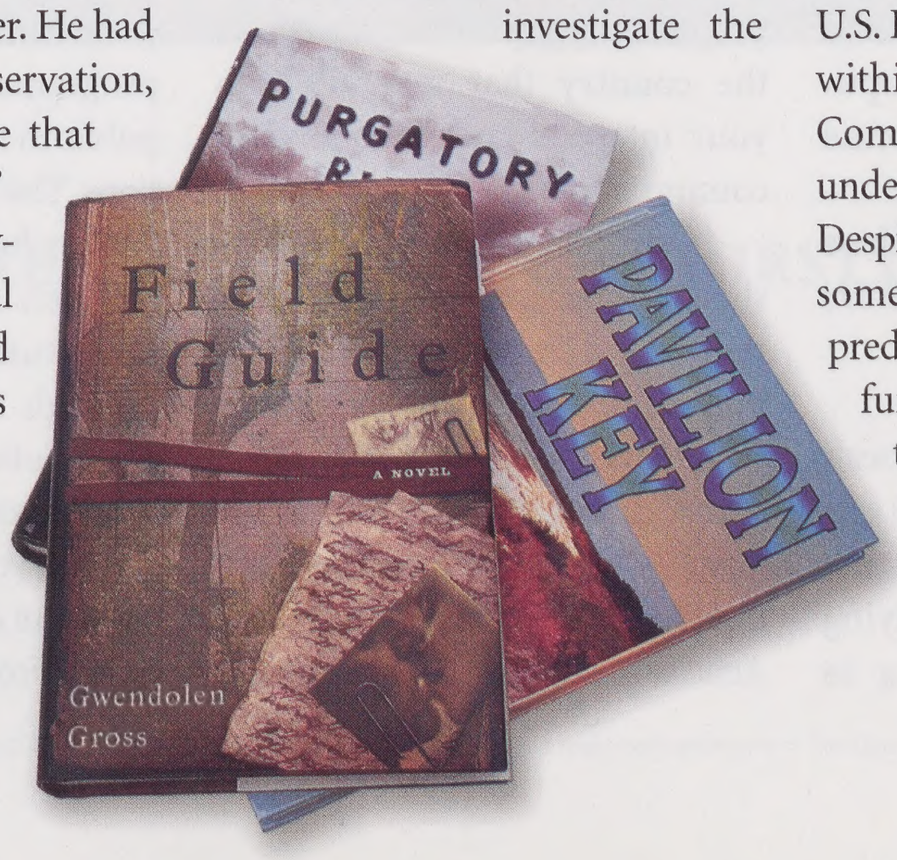
It's not Shakespeare. Heck, it's not even Tom Clancy. But if you're looking for a book to breeze through while lounging under the beach umbrella, then pick up a copy of *Pavilion Key: Isle of Buried Treasure.*

When Florida Game and Fresh Water Fish Commission Officer Hal Nobel agrees to help a friend investigate the suspicious disturbance to some sea-turtle nests on Pavilion Key, he finds more than he bargained for—murder, mayhem, and scientific discovery, with some romance thrown in for good measure. As with his novel *Ivory Hunters: A Novel of Extinction*, author Greg Lewbart weaves lessons on natural history and other biological tidbits into his story. Sometimes these instructive forays—seemingly aimed at a teenage mind—go awry. When one character's Ford Explorer flips over into a canal (the driver was trying to avoid a radio-collared Florida panther, of course), Lewbart explains:

"Soon his face was engulfed by the fatal liquid and he held his breath in a final desperate attempt to sustain himself. The metabolic processes in his body continued to produce carbon dioxide, the stimulus for breathing in mammals, while they used up the dwindling oxygen supply in his bloodstream."

Blatant inaccuracies elsewhere in the book tempted me to cross-check all of the author's biological facts. Lewbart authoritatively tells his readers, for example, that the U.S. Fish & Wildlife Service resides within the Department of Commerce, when it actually falls under the Department of Interior. Despite these errors, not to mention somewhat flat characters and a predictably pat ending, the story is fun and will keep the pages turning. Read the book—then pass it along to your favorite middle-schooler.

—*Sue Zwicker*



BIO-ALMANAC

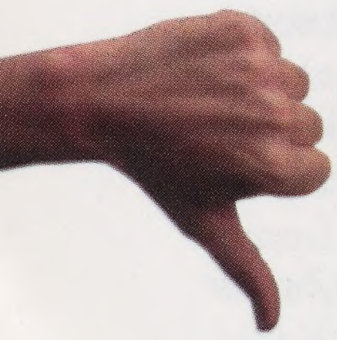
GOOD NEWS

On March 25, a California condor (*Gymnogyps californianus*) egg was laid in the wild for the first time in 15 years. The mother chose a scenic location for the historic occasion: a cave in the Grand Canyon. Although biologists from the Peregrine Fund found the egg broken, they remain optimistic, because condor eggs often are accidentally fractured by first-time parents.

The mother condor herself had been released into Grand Canyon National Park with eight other condors in 1997 as part of a reintroduction effort for this endangered species. Shooting and poisoning by farmers and hunters, along with habitat loss, had brought condors to the very brink of extinction, and by 1982 only 22 remained in the world. Biologists captured the last remaining wild condors in 1987 for breeding in zoos. The decision has paid off: The 100th captive-bred condor hatched this past April. About 50 California condors now live in the wild, along with about 110 in breeding facilities and pre-release field pens.

Adult condors can weigh up to 24 pounds and boast wingspans of nearly ten feet. They once ranged from British Columbia south to Baja California, but current wild populations are restricted to California and Arizona.

—*from* Environmental News Service *(3/29/01)*



BAD NEWS

Southern elephant seals (*Mirounga leonina*) and other giant marine mammals may be dying off from something as small as a louse. Australian scientists recently announced the discovery of a type of arbovirus carried by lice (*Lepidophthirus macrorhini*) infecting the colony of elephant seals on Macquarie Island, 1,250 miles south of Australia. The population of about 70,000 to 80,000 elephant seals there has dropped by more than 50 percent over the last four decades, despite protection from the Australian government.

A variety of marine mammals around the world are in decline, prompting scientists to explore possible links between pollutants in the ocean and suppressed immune systems, leading to higher incidences of viral infections. Such infections may increase the chance that seals or whales will beach and may put them at greater risk of starvation. Previously unknown in marine mammals, arboviruses affect many terrestrial mammals and can cause rheumatism and encephalitis in humans.

—*from* New Scientist *(5/12/01)*

ACT LOCALLY!

Want to do something for local wildlife that's more hands-on than recycling, composting, or hanging bird feeders? Whether it's monitoring wildlife, creating new habitats, or cleaning up existing ones, programs are sprouting up across the country that may fit both your interests and your level of commitment.

In the Chesapeake Bay watershed, protecting the Bay means reducing contaminants from upstream. To help, you can wile away your weekends stenciling storm drains in Prince George's County, Maryland, spend an afternoon removing trash from the Anacostia River, or monitor streams every three months in Fairfax, Virginia. If you'd rather muck about your own garden, a myriad of programs—such as the Alliance for the Chesapeake/U.S. Fish & Wildlife Service *BayScapes*—can help you plan beautiful landscapes that attract wildlife, require minimal watering and pesticide applications, and reduce runoff into area waterways and storm drains. The movement toward wildlife-friendly landscaping has had a dramatic positive impact on some species. After trading ornamental plantings for native warm-season grasses in the Middle Patuxent Environmental Area, residents of Howard County, Maryland, have witnessed the return of American woodcocks (*Philohela minor*)—small wading birds related to sandpipers. On the Eastern Shore of Maryland, a single farmer has attracted breeding pairs of dickcissel (*Spiza americana*) and grasshopper sparrows (*Ammodramus savannarum*)—both increasingly rare species—by planting and restoring the native grasses they require.

JESSIE COHEN/NZP

THE GHOSTLY LEMUR.

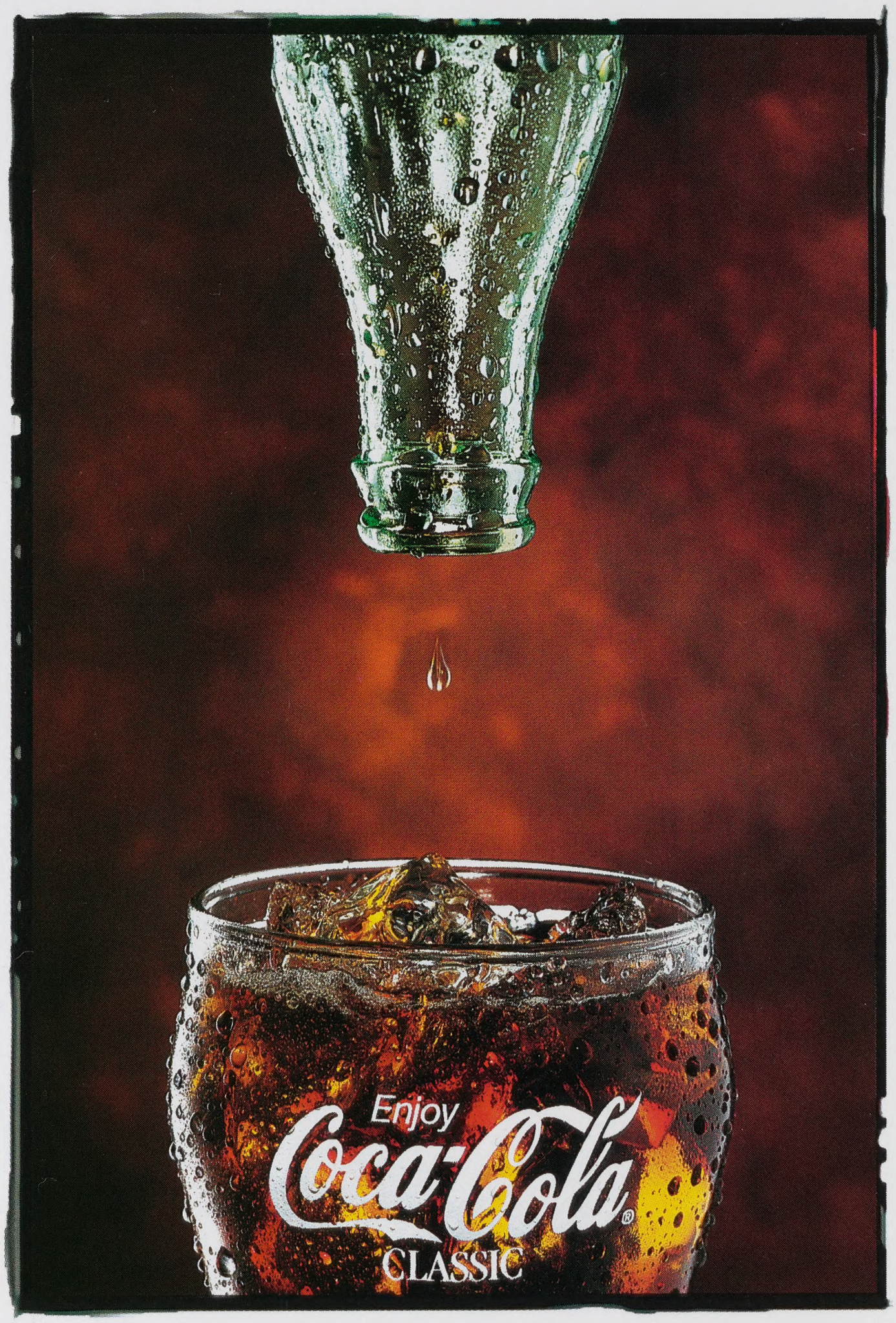
Alternatively, you can commit your time to one of various programs designed to enlist the public in studying wildlife populations. The Maryland Ornithological Society has catalogued two dozen "Citizen Science for Birders" opportunities, many of them through the Cornell Lab of Ornithology/Audubon Society *BirdSource* website. If frog croaking is more your tune than bird song, check out one of the programs listed on the Frogwatch USA website. For links to more information on all of these programs, go to: www.fonz.org/zoogoer/zg2001/30(4)bioalmanac.htm.

WHAT'S IN A NAME?

How did a boy raised by wolves lend his name to a primate from Madagascar? The word "lemur" derives from the Latin word, *lemures*—meaning specters or spirits of the dead—and was given to these prosimians on account of the animals' ghostly faces and nocturnal habits. The evolution of this Latin word has its own haunted history. According to ancient mythology, the city of Rome was founded by twin brothers Romulus and Remus, who had been suckled by a she-wolf as babies. Arguing over who should rule the new city, Romulus murdered Remus and named the city after himself. But the ghost of the fallen brother haunted Rome from then on. Every May, citizens of Rome would hold a festival—first called Remuria, but later corrupted to Lemuria—to expiate the ghost of Remus and other ancestral spirits. From this tradition grew the word *lemures*, one of several Latin words—including *larva*, the shell of a ghost—used to refer to various forms of phantom.

"Lemuria" also is the name of a mythological sunken supercontinent, akin to Atlantis, once believed to lie in the Indian Ocean—coincidentally near the real lemur's native home.

—*Alex Hawes and Sue Zwicker*



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